

UNITED STATES OF AMERICA:  
WAR DEPARTMENT.

# MONTHLY WEATHER REVIEW.

(GENERAL WEATHER SERVICE OF THE UNITED STATES.)

DECEMBER, 1886.

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1887.

List of merchant marine steam and sailing vessels from which International Simultaneous Meteorological reports were received at the Office of the Chief Signal Officer, U. S. Army, Washington, D. C. in time to be used in the preparation of the Weather Review for the month of December, 1886.

Name of vessel.	Captain.	Name of vessel.	Captain.	Name of vessel.	Captain.
<i>Albatross Line.</i>		<i>Mediterranean &amp; New York S. S. Co.</i>		<i>White Star Line.</i>	
Br. s. s. <i>Greene</i> .....	Capt. C. E. Le Gallais.	Br. s. s. <i>Pontiac</i> .....	Ch. Off. R. Blyth	Br. s. s. <i>Adriatic</i> .....	Capt. H. Farrell.
Mauihan.....	W. Ambry.	<i>Miss &amp; Dominion S. S. Co.</i>		Britannic.....	H. Perry.
Nova Scotia.....	E. H. Hughes.	Br. s. s. <i>Ontario</i> .....	Capt. W. P. Couch.	Germanic.....	Benj. Gleadell.
Sardinian.....	W. H. Smith.	Toronto.....	Jas. McAnley.		
Scandinavian.....	John Park.	<i>Monarch Line.</i>		<i>Willam Line.</i>	
<i>American Line.</i>		Br. s. s. <i>Assyrian Monarch</i> .....	John Sparks.	Br. s. s. <i>Buffalo</i> .....	J. H. Malet.
Br. s. s. <i>British King</i> .....	John Kelly.	Lydon Monarch.....	T. C. Huggott.	Galicia.....	R. Potter.
British Prince.....	S. Nowell.	Pennina Monarch.....	John Harrison.	Salerno.....	B. H. Rogers.
British Princess.....	E. H. Freeth.	<i>Morgan Line.</i>			
Paduan.....	B. W. Sargent.	Br. s. s. <i>Canada</i> .....	R. B. Quick.	Br. s. s. <i>Angerton</i> .....	S. M. Orr.
Lord Clive.....	P. Urquhart.	Denmark.....	Thos. Foot.	Athens.....	Ch. Off. Emi Towne.
Lord Clough.....	E. M. Hughes.	Egypt.....	R. S. Rigby.	Amictis.....	Capt. P. M. Belmore.
<i>Anchor Line.</i>		England.....	J. Sumner.	Bedford.....	T. Altknecht.
Br. s. s. <i>Acadia</i> .....	C. W. Haynes.	Erie.....	T. F. Hensley.	Elstow.....	T. Robertson.
Bolivia.....	J. J. Small.	France.....	J. Robinson.	Elcano.....	V. Jaspina.
British Crown.....	E. Will.	Greece.....	A. D. Hadley.	Fitroy.....	Henry Gibb.
British Queen.....	A. Campbell.	Holland.....	A. J. Jeffrey.	Hudson.....	M. Wanders.
Chiriqui.....	Haag Young.	Italy.....	W. Tyson.	Leo.....	C. J. Canles.
Dorville.....	J. McKague.	Spain.....	W. Pearce.	Lorenzo D. Baker.....	Warren F. Wiley.
Ethiopia.....	John Wilson.	<i>Navigazione Generale Italiana.</i>	W. A. Grimiths.	Ludwig Holberg.....	N. Houge.
Olympia.....	Thos. Craig.	Br. s. s. <i>Independence</i> .....	P. Pirandello.	Manuel L. Villaverde.....	Claudio Perales.
<i>Armer Line.</i>		Br. s. s. <i>Polcevera</i> .....	Broffech.	Saint Bonas.....	J. Viereck.
Br. s. s. <i>Monte Rosa</i> .....	C. Thomas.	<i>New York and Cuba Mail S. S. Co.</i>		Stag.....	Henry Campbell.
<i>Atlas Line.</i>		Am. s. s. <i>Chesapeake</i> .....	F. M. Faircloth.	Strathleven.....	Jas. Adams.
Br. s. s. <i>Atlas</i> .....	J. W. Sansom.	N. Y., <i>Hudson &amp; Montreal Mail S. S. Co.</i>		Viola.....	C. W. Pearson.
Andes.....	T. M. MacKnight.	Am. s. s. <i>City of Alexandria</i> .....	J. W. Reynolds.		L. Murray.
<i>Black &amp; S. S. Co. (Limited).</i>		City of Washington.....	W. H. Rittig.	<i>New York Herald Weather Service.</i>	
Br. s. s. <i>Chesnut</i> .....	Thomas Burley.	<i>North German Lloyd Steamship Co.</i>		Br. s. s. <i>Alene</i> .....	Siders.
Jerome.....	Benj. Crimp.	Ger. s. s. <i>America</i> .....	H. Christoffers.	Alvina.....	F. McKay.
<i>Hotel-Clay Line.</i>		Elder.....	H. Backer.	Athens.....	H. Low.
Br. s. s. <i>Brooklyn City</i> .....	W. Hill.	Enns.....	H. Helmers.	Barracosta.....	H. Bernpoint.
Wells City.....	T. L. Weiss.	Frank.....	T. Jungst.	Caracas.....	W. M. Hopkins.
<i>Clyde Steamship Company.</i>		Hermann.....	E. Ring.	Chalmers.....	J. D. Perry.
Br. s. s. <i>Yonah</i> .....	S. C. Platt.	Sale.....	A. Kohlmann.	Chateau Lafite.....	C. Olive.
<i>Chesnut Line.</i>		Werra.....	H. Reicher.	City of Chicago.....	Fred Watkins.
Br. s. s. <i>Louisiana</i> .....	E. V. Gager.	<i>Ocean Steamship Company.</i>		City of Puebla.....	F. Deakon.
<i>Overland Line.</i>		Am. s. s. <i>Chattahoochee</i> .....	J. W. Catharine.	City of Richmond.....	A. Redford.
Br. s. s. <i>Aurora</i> .....	W. H. P. Hains.	Old Dominion Steamship Company.		Comal.....	F. Bolger.
Catalonia.....	Alex. McKay.	Am. s. s. <i>Manhattan</i> .....	Frank Stevens.	East Angia.....	W. S. Morgan.
Cephalonia.....	Henry Walker.	Oregon Railway and Navigation Co.		Egyptian Monarch.....	J. W. Hawthorne.
Galicia.....	M. Murphy.	Am. s. s. <i>Oregon</i> .....	E. Polemann.	El Monte.....	H. S. Quick.
Etruria.....	T. Cook.	Pacific Coast Steamship Company.		El Paso.....	H. Bernpoint.
Galania.....	T. Roberts.	Am. s. s. <i>City of Chester</i> .....	J. Wallace.	Furnessia.....	H. R. Freeman.
Georgia.....	H. McKay.	Am. s. s. <i>Orizaba</i> .....	John N. Ingalls.	Hudson.....	T. H. Gore.
Edmund Carr's S. S. Line.		Pacific Mail Steamship Company.		Llandaff City.....	G. W. Mason.
Br. s. s. <i>Amalfi</i> .....	Julius Bahr.	Am. s. s. <i>Acapulco</i> .....	C. S. Coys.	Lone Star.....	F. E. Jenkins.
Polymnia.....	A. Kuhn.	City of New York.....	R. R. Searle.	Miranda.....	E. Bendon.
<i>Parsons Line.</i>		City of Para.....	L. Dexter.	Morgan City.....	J. D. Percy.
Br. s. s. <i>Bordeaux</i> .....	F. Manley.	Colon.....	Chas. C. Lima.	Newport.....	W. G. Shackford.
Burham Clay.....	M. P. Lund.	San Blas.....	Thos. Chapman.	New York.....	J. G. Percy.
Stockholm City.....	K. Doyle.	<i>Quebec Steamship Company.</i>		Niagara.....	G. V. Bemis.
<i>General Trans-Atlantic Steamship Co.</i>		Br. s. s. <i>Muriel</i> .....	G. S. Locke.	Portia.....	H. Dawson.
Br. s. s. <i>La Bourgogne</i> .....	E. Franguel.	Orizaba.....	J. S. Garvin.	Republic.....	P. J. Irving.
La Bourgogne.....	M. de Jousellin.	Trinidad.....	W. J. Fraser.	Samaus.....	W. Taylor.
La Champagne.....	E. Trank.	Red "D" Line.....		Sacramento.....	R. S. Thompson.
La Gascogne.....	Santelli.	Am. s. s. <i>Philadelphia</i> .....	Sam. Hess.	Vancouver.....	C. Lindall.
Normandie.....	G. de Kersabiec.	Valencia.....	W. Woodrick.	W. A. Scholten.....	G. J. Vin.
<i>Grand Western S. S. Line.</i>		<i>Red Star Line.</i>		<i>Sailing vessels.</i>	
Br. s. s. <i>Dorset</i> .....	Ch. Off. E. Crossman.	Belg. s. s. <i>Belgianland</i> .....	W. A. Beynon.	Am. bg. <i>Abbie Clifford</i> .....	D. W. Storer.
<i>Union Line.</i>		Niederland.....	A. J. Griffin.	Br. bg. <i>Ada Pearl</i> .....	N. Hocken.
Br. s. s. <i>Alaska</i> .....	Geo. S. Murray.	Nordland.....	H. E. Nickels.	bg. <i>Adria</i> .....	J. H. Weldon.
Arizona.....	S. Brooks.	Pennland.....	Bad. Weyer.	Am. schr. <i>Anna B. Hutchinson</i> .....	O. C. Grönan.
Nevada.....	John Douglas.	Rhynland.....	J. C. Jamison.	bg. <i>Arctot</i> .....	D. Zelnit.
Wyoming.....	C. L. Rigby.	Wesland.....	J. Ueberweg.	Ger. bk. <i>Arnold von Bippen</i> .....	J. W. Cates.
<i>Hamburg-American Line.</i>		Westernland.....	Com. W. G. Randle.	Am. schr. <i>C. B. Church</i> .....	T. Möller.
Br. s. s. <i>Bavaria</i> .....	G. Rosing.	<i>Holland Line.</i>		Br. schr. <i>Chas. S. Whitney</i> .....	Ch. Off. A. P. Goodman.
Gallert.....	W. Kühlewein.	Dutch s. s. <i>Edam</i> .....	Capt. J. H. Taat.	Am. schr. <i>Comet</i> .....	Capt. N. A. Anderson.
Gothia.....	C. Kordell.	Leerdam.....	P. Stierendregt.	bk. <i>Crescent</i> .....	Geo. D. Spicer.
Hungaria.....	H. Leithausen.	P. Caland.....	T. H. Bonjer.	Ger. sp. <i>Dakota</i> .....	W. H. Aldrich.
Moravia.....	O. Pesoldt.	Schiedam.....	A. Potjer.	Am. bg. <i>Daisy Boynton</i> .....	W. P. Gibbs.
Rhaetia.....	H. Vogelgsang.	Zaandam.....	H. v. d. Zee.	Ger. bk. <i>Emilie</i> .....	N. E. Shaffer.
Rugia.....	A. Albers.	<i>Royal Mail Steamship Co.</i>		Am. bk. <i>Ethel</i> .....	C. Harding.
Saxonia.....	H. Schmidt.	Am. s. s. <i>City of Dallas</i> .....	C. W. Read.	Br. sp. <i>F. B. Taylor</i> .....	W. Thompson.
Wieland.....	C. Heibich.	State Line.....		Am. bk. <i>Harriet S. Jackson</i> .....	J. A. Tilley.
Westphalia.....		Br. s. s. <i>State of Georgia</i> .....	G. Mocle.	Ger. sp. <i>Hedwig</i> .....	W. T. Bacon.
<i>Hudson Line.</i>		State of Pennsylvania.....	A. J. A. Mann.	Am. bg. <i>Jane Adeline</i> .....	C. Uttenness.
Br. s. s. <i>Counsellor</i> .....	Wm. Lang.	State of Nebraska.....	A. G. Braas.	bk. <i>James S. Stone</i> .....	G. W. Cates.
<i>Human Line.</i>		State of Nevada.....	J. A. Stewart.	schr. <i>John S. Wood</i> .....	W. F. Barstow.
Br. s. s. <i>City of Berlin</i> .....	Francis S. Land.	<i>Thinevalle Line.</i>		bk. <i>Josephine</i> .....	W. S. Bernard.
City of Chester.....	A. Lewis.	Island.....	C. W. Miller.	bk. <i>L. &amp; W. Armstrong</i> .....	Asmus Lenhard.
<i>Empire &amp; North's Steamship Company.</i>		Thingvall.....	W. Skjold.	bk. <i>Lillian</i> .....	Chas. Brown.
Br. s. s. <i>Beaul</i> .....	C. J. Watson.	Thingvall.....	S. T. H. Laub.	bk. <i>Minnie G. Whitney</i> .....	A. Alexander.
Thales.....	Jas. Glasspools.	<i>Twin Screw Line.</i>		bk. <i>Morland</i> .....	H. F. Schive.
<i>Lytham Line.</i>		Br. s. s. <i>Tower Hill</i> .....	F. Archer, R. N. R.	Am. bg. <i>Morancy</i> .....	J. D. Foley.
Br. s. s. <i>Bavaria</i> .....	H. Lusk.	Br. s. s. <i>City of Newcastle</i> .....	R. Townsend.	schr. <i>N. Hand</i> .....	T. Omundsen.
Boisgiron.....	E. Parry.	<i>Warren Line.</i>		Ger. sp. <i>Palme</i> .....	W. Babbie.
Isleth.....	T. H. Fox.	Br. s. s. <i>Iowa</i> .....	Samuel Walters.	Am. bg. <i>Pearl</i> .....	John B. Zimmer.
Virginia.....	M. Pitt.	Kansas.....	W. Gleig.	Ger. bk. <i>Pillau</i> .....	G. Gerlach.
<i>Hall's Line.</i>		Norrmann.....	E. Maddox.	Br. bk. <i>Rosebud</i> .....	John Collie.
Br. s. s. <i>Alamo</i> .....	S. Risk.	<i>Wells Ward Line.</i>		bk. <i>Rosebud</i> .....	G. Tomacelli.
Colorado.....	Jas. Daniels.	Br. s. s. <i>Camden</i> .....		bk. <i>Rosebud</i> .....	D. Kelfie.
Lampasas.....	M. B. Crowell.	Chiswick.....		Am. schr. <i>Winnie Lawry</i> .....	A. McRitchie.
Nio Grande.....	J. F. Lewis.	<i>White Cross Line.</i>		Light-ship No. 37.....	Andrew Jackson.
San Marcos.....	A. C. Burrows.	Belg. s. s. <i>Pieter de Coninck</i> .....	E. Smitt.		



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## INTRODUCTION.

This REVIEW contains a general summary of the meteorological conditions which prevailed over the United States and Canada during December, 1886, based upon the reports from the regular and voluntary observers of the Signal Service and from co-operating state weather services.

Descriptions of the storms which occurred over the north Atlantic Ocean during the month are also given, and their approximate paths shown on chart i. In tracing the centres of the paths of these storms, data from the reports of one hundred and sixty-seven vessels have been used.

No ocean ice has been reported during the month in, or to the southward of, the trans-Atlantic routes.

On chart i for this month are traced the paths of eleven areas of low pressure; the average number for December during the past fourteen years being 12.4. No severe storm occurred during the month, although the storm of the 1st on the Lakes displayed considerable energy, and the low area that passed across the east Gulf states and southern part of the south Atlantic states on the 4th, and thence up the coast on the 5th and 6th, was notable for the very heavy snowfall that attended its passage through the Southern States.

The mean atmospheric pressure of the month is slightly above the normal over the greater part of the United States; the departures are comparatively large in the upper Mississippi valley, the Missouri Valley, and in Dakota and Minnesota.

From the one hundred and fifth meridian eastward the temperature of the air has been below the normal, westward of that meridian the month has been warmer than the average December.

The precipitation of December, 1886, is nearly normal in all parts of the country, except in California and the south Atlantic and Gulf states where it is deficient, and in the north Pacific coast region where it is excessive.

In the preparation of this REVIEW the following data, received up to January 20, 1887, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at one hundred and thirty-three Signal Service stations and twenty-two Canadian stations, as telegraphed to this office; one hundred and sixty-five monthly journals; one hundred and fifty-nine monthly means from the former, and twenty-two monthly means from the latter; two hundred and ninety-three monthly registers from voluntary observers; forty-five monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the "New York Herald Weather Service;" abstracts of ships' logs furnished by the publishers of "The New York

Maritime Register;" monthly weather reports from the local weather services of Alabama, Colorado, Indiana, Illinois, Iowa, Minnesota, Missouri, New England, Ohio, and Tennessee; trustworthy newspaper extracts, and special reports.

## ATMOSPHERIC PRESSURE.

[Expressed in inches and hundredths.]

The distribution of mean pressure for December, 1886, determined from the tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii.

It will be seen from this chart that the mean pressure of the month is greatest over Dakota, Minnesota, the Missouri Valley, and the upper Mississippi valley; in these districts it averages 30.23, and varies from 30.20 to 30.25; another area of high pressure, enclosed by the isobar of 30.20, extends over southern Idaho, southeastern Oregon, and the northern part of Nevada and Utah. The area of minimum pressure covers the western part of Washington Territory, in this district the pressure averages about 29.95; at one station, Tatoosh Island, the mean pressure of the month is only 29.88. Another area of comparatively low pressure extends over New England and the Canadian Maritime Provinces; in these districts the mean pressure of the month varies from 30.08 at Boston, Massachusetts, and Block Island, Rhode Island, to 30.01 at Father Point, Canada.

The departures from the normal pressure are given in the table of miscellaneous meteorological data, and are also shown on chart iv by lines connecting stations of equal departure. The pressure of the month is above the normal in almost every district of the United States, but the excess is nowhere very great; the largest departures are found in the same region as the area of maximum pressure, viz., Dakota, Minnesota, the Missouri Valley, and the upper Mississippi valley, in this region the departures in excess of the normal vary from .08 at Fort Buford, Dakota, and Davenport, Iowa, to .13 at Bismarck, Dakota. The departures in the Lake region and in New England are comparatively large, varying from .04 at Block Island, Rhode Island, to .09 at Chicago, Illinois. The pressure in California, Nevada, Utah, and western Arizona is also in excess of the normal, the departures averaging .06. In the middle and south Atlantic states, Florida, and the Gulf states, the mean pressure is normal or very nearly so, no departures occurring in these districts larger than .03. In the northern plateau region and along the north Pacific coast the mean pressure of the month is below the normal, but the deficiencies are small, the largest departure being .10 at Tatoosh Island, Washington Territory.

As compared with the pressure of the preceding month very large differences, both above and below, occur in nearly all parts of the United States; in the northern plateau region and along the north Pacific coast the pressure for December averages about .20 below that of November, and varies from .16 below at Walla Walla, Washington Territory, to .28 below at Tatoosh Island, Washington Territory. Along the eastern slope of the Rocky Mountains and eastward to the Atlantic the pressure for December is considerably above that of November, the greatest increase is in Dakota, Montana, the Missouri Valley, and the upper Mississippi valley, and the Lake region, in these districts it averages about .17.

## BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Ser-

vice stations are given in the table of miscellaneous data. The following are some of the extreme monthly ranges:

Greatest.	Least.
Mount Washington, New Hampshire..... 1.53	San Diego, California..... 0.30
Basport, Maine..... 1.53	Los Angeles, California..... 0.33
Saint Vincent, Minnesota..... 1.50	Yuma, Arizona..... 0.40
Portland, Maine..... 1.44	Key West, Florida..... 0.41
Fort Buford, Dakota..... 1.41	San Francisco, California..... 0.48
Fort Totten, Dakota..... 1.38	Sacramento, California..... 0.54
Rochester, New York..... 1.36	Fort Grant, Arizona..... 0.54
Moorhead, Minnesota..... 1.34	New Orleans, Louisiana..... 0.60

#### AREAS OF HIGH PRESSURE.

[Prepared by Lieut. JOHN P. FINLEY, Signal Corps, U. S. Army, Assistant.]

The tracks of eight areas of high pressure were traced within the limits of the Signal Service charts for the month of December, 1886. With three exceptions these areas entered the United States from the region of country north of Montana and Dakota. One area began its progressive movement eastward from Washington Territory, one northeastward from North Carolina, and another eastward from Lower Canada.

Area number i passed nearly due southward from Manitoba, British America, to the Rio Grande Valley, Texas, following in rear of depression number iii, which was moving eastward along the northern coast of the Gulf of Mexico.

The information relating to the development and movement of high pressure areas is given in the accompanying table, and the designations employed are explained as follows:

The times, 7 a. m., 3 p. m., and 10 p. m., are the hours (75th meridian time) at which the tri-daily telegraphic meteorological observations are made at Signal Service stations.

These observations are used in the preparation of the daily weather maps from which indications are made, and from a study of which the tracks of high pressure areas are charted and described.

Barometric departure refers to the maximum deviation of of pressure from the normal within the central area, which deviation in all cases will have the plus sign.

Temperature departure refers to the maximum deviation of temperature from the normal within the central area, which deviation in all cases will have the minus sign.

Table of high pressure areas.

Number of area.	Date.	Hour of observation.	Location of central storm area.	Barometer departure.	Temperature departure.	Remarks.
				Inches.	°	
I.....	3	3 p. m.	Manitoba.....	+0.81	-26	This area remained stationary off the Texas coast for the succeeding 48 hours, when the central area of maximum pressure was suddenly shifted to Georgia, in which region it again became stationary until the morning of the 11th, when it moved north-eastward as No. III.
	4	10 p. m.	Northern Minnesota.....	+0.83	-31	
	7	7 a. m.	Southeast Dakota.....	+0.84	-46	
	10	3 p. m.	Southwest Iowa.....	+0.73	-34	
	10	3 p. m.	Eastern Kansas.....	+0.57	-23	
	5	7 a. m.	Northern Texas.....	+0.51	-35	This area disappeared eastward over the Atlantic during the day.
	10	3 p. m.	Southern Texas.....	+0.45	-35	
II.....	6	7 a. m.	Lower Canada.....	+0.40	-23	This area disappeared eastward over the Atlantic during the day.
	10	3 p. m.	Upper Canada.....	+0.47	-15	
	10	3 p. m.	Northern Maine.....	+0.59	-14	
III.....	7	7 a. m.	New Brunswick.....	+0.58	-11	This area disappeared eastward over the Atlantic during the day.
	10	3 p. m.	Gulf of Saint Lawrence.....	+0.50	-3	
	10	3 p. m.	Southwest Virginia.....	+0.31	-15	
IV.....	18	7 a. m.	Washington Territory.....	+0.32	-3	The development of this area was probably influenced by a region of high pressure (30.20 to 30.60) which remained about stationary in Nevada and Utah from the morning of the 11th to the morning of the 16th, when it appeared to move northward, and finally gave rise to the movement southeastward of No. IV.
	10	3 p. m.	Western Montana.....	+0.40	-2	
	10	3 p. m.	Northern Colorado.....	+0.43	-15	
	19	7 a. m.	Southwestern Kansas.....	+0.44	-12	
	10	3 p. m.	Northern Texas.....	+0.40	-7	
	20	7 a. m.	Texas coast.....	+0.34	-16	
	10	3 p. m.	Southern Mississippi.....	+0.23	-12	
	10	3 p. m.	Central Georgia.....	+0.19	-15	
	21	7 a. m.	South Carolina.....	+0.22	-18	

Table of high pressure areas—Continued.

Number of area.	Date.	Hour of observation.	Location of central storm area.	Barometer departure.	Temperature departure.	Remarks.
				Inches.	°	
V.....	20	10 p. m.	North of Montana.....	+0.11	-11	This area remained about stationary in Georgia and South Carolina during the succeeding 48 hours, at the expiration of which time it merged with area No. V, then central in the Ohio Valley.
	21	7 a. m.	Southeastern Dakota.....	+0.19	-15	
		3 p. m.	Northern Kansas.....	+0.19	-9	
		10 p. m.	Northern Missouri.....	+0.21	-7	
	22	7 a. m.	Southern Illinois.....	+0.23	-17	
		3 p. m.	Central Ohio.....	+0.31	-4	This area disappeared eastward over the Atlantic during the day.
		10 p. m.	Lake Erie.....	+0.39	-9	
	23	7 a. m.	New Hampshire.....	+0.49	-15	
		3 p. m.	Eastern Maine.....	+0.54	-3	
		10 p. m.	Nova Scotia.....	+0.62	-9	
VI.....	24	7 a. m.	South of Newfoundland.....	+0.59	-8	This area disappeared eastward over the Atlantic during the day.
		3 p. m.	North of Dakota.....	+0.27	-31	
		10 p. m.	Northern Minnesota.....	+0.22	-34	
	25	7 a. m.	Northern Michigan.....	+0.24	-24	
		3 p. m.	Lower Canada.....	+0.33	-23	
		10 p. m.	Upper Canada.....	+0.35	-34	This area remained stationary over Illinois and Indiana until the morning of the 29th, when it merged with area No. VIII, then central over Lake Superior.
	26	7 a. m.	New Brunswick.....	+0.44	-20	
		3 p. m.	Gulf of Saint Lawrence.....	+0.50	-18	
VII.....	25	10 p. m.	Eastern Montana.....	+0.36	-37	
	26	7 a. m.	Central Dakota.....	+0.29	-43	
		3 p. m.	Southeastern Dakota.....	+0.31	-44	This area disappeared eastward over the Atlantic during the day.
		10 p. m.	Eastern Nebraska.....	+0.34	-43	
	27	7 a. m.	Southern Iowa.....	+0.42	-45	
		3 p. m.	Northeastern Missouri.....	+0.41	-39	
VIII.....	28	10 p. m.	Central Illinois.....	+0.40	-30	
		3 p. m.	North of Dakota.....	+0.37	-21	This area disappeared eastward over the Atlantic during the day.
		10 p. m.	Northern Minnesota.....	+0.41	-24	
	29	7 a. m.	Lake Superior.....	+0.42	-24	
		3 p. m.	Lower Canada.....	+0.48	-29	
		10 p. m.	Upper Canada.....	+0.54	-35	
	30	7 a. m.	Northeastern Maine.....	+0.63	-37	
		3 p. m.	New Brunswick.....	+0.69	-32	
		10 p. m.	Gulf of Saint Lawrence.....	+0.74	-35	

#### AREAS OF LOW PRESSURE.

[Prepared by Lieut. JOHN P. FINLEY, Signal Corps, U. S. Army, Assistant.]

The tracks of eleven areas of low pressure have been charted from a study of the tri-daily weather charts of the Signal Service for the month of December, 1886.

In the majority of cases the depressions began their progressive movement to the eastward, within the limits of observation, west of the one hundred and second meridian.

Areas numbers iv and viii, during their progressive movement eastward, were generally without the limits of Signal Service stations, and, therefore, their paths are approximately located.

Areas numbers ix, x, and xi, during their progressive movement to the eastward, made a decided curve to the southward in the vicinity of 35° N., 102° W., under the influence of high-pressure areas numbers vi, vii, and viii, advancing southeastward from British America.

The following table shows the latitude and longitude in which each area of low pressure was first and last observed, with the average rate of translation in miles per hour:

Areas of low pressure.	First observed.		Last observed.		Average velocity of translation in miles per hour.
	Lat. N.	Long. W.	Lat. N.	Long. W.	
No. I.....	45 00	69 00	48 00	61 00	17.0
II.....	46 00	83 00	47 00	58 00	22.0
III.....	28 00	100 00	40 00	58 00	23.0
IV.....	51 00	112 00	51 00	61 00	46.0
V.....	35 00	109 00	50 00	62 00	25.0
VI.....	43 00	86 00	47 00	62 00	24.0
VII.....	52 00	111 00	48 00	63 00	34.0
VIII.....	51 00	109 00	51 00	67 00	45.0
IX.....	47 00	124 00	51 00	62 00	38.0
X.....	42 00	107 00	47 00	58 00	33.0
XI.....	40 00	106 00	41 00	77 00	39.0

Average rate of movement, 31.4 miles per hour.

The information descriptive of low-pressure areas is given in the accompanying table, and that the designations em-



played may be more clearly understood the following explanations are necessary:

The times, 7 a. m., 3 p. m., and 10 p. m., are the hours (75th meridian time) at which the tri-daily telegraphic meteorological observations are made at Signal Service stations. These observations are used in the preparation of the tri-daily weather maps from which indications are made, and from a study of which the tracks of low-pressure areas are charted and described.

Barometric departure refers to the maximum deviation of pressure from the normal within the central area, which deviation in all cases will have the minus sign.

Precipitation refers to all rain or snow that has fallen during the past eight hours, or since the last observation. In order to show, approximately, the distribution of precipitation about and within the central area of low pressure, the four quadrants of the depression are separately considered by designating the number of stations in each at which precipitation has taken place.

Table of low-pressure areas.

Number of area.	Date.	Hour of observation.	Location of central area of low pressure.	Barometric departure.	No. of stations reporting precipitation.				Remarks.
					NE. quadrant.	SE. quadrant.	SW. quadrant.	NW. quadrant.	
I	1	7 a. m.	Central Maine.....	Inches. —0.67	4	*	21	6	This area is a continuation of No. 14, described in the Review for November, 1886.
		3 p. m.	Northern Maine.....	—0.52	4	†	26	*	
		10 p. m.	New Brunswick.....	—0.52	†	1	21	†	
II	2	7 a. m.	Gulf of Saint Lawrence.	—0.52	*	1	2	*	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	do.....	—0.45	*	*	6	*	
		10 p. m.	do.....	—0.45	*	*	6	*	
III	3	7 a. m.	North of Lake Huron...	—0.40	...	...	...	...	Up to the morning of the 2d this area appeared as a secondary depression to No. 1, during which time the precipitation was considered in connection with the latter.
		3 p. m.	Lower Canada.....	—0.46	...	...	...	...	
		10 p. m.	do.....	—0.52	...	...	...	...	
IV	4	7 a. m.	New Hampshire.....	—0.57	3	*	12	7	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Coast of Maine.....	—0.59	4	*	10	5	
		10 p. m.	New Brunswick.....	—0.58	2	*	13	5	
V	5	7 a. m.	Gulf of Saint Lawrence.	—0.73	*	1	10	*	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	do.....	—0.45	*	*	6	*	
		10 p. m.	do.....	—0.45	*	*	6	*	
VI	6	7 a. m.	Rio Grande Valley.....	—0.19	8	†	*	1	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Coast of Texas.....	—0.18	11	*	†	†	
		10 p. m.	Coast of Louisiana.....	—0.18	15	*	2	†	
VII	7	7 a. m.	Western Florida.....	—0.18	14	2	10	10	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Northern Florida.....	—0.17	12	*	13	13	
		10 p. m.	East coast of Florida...	—0.27	16	*	4	9	
VIII	8	7 a. m.	Off coast of Georgia...	—0.28	15	*	4	4	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Off coast of South Carolina.	—0.39	14	*	10	4	
		10 p. m.	do.....	—0.39	14	*	10	4	
IX	9	7 a. m.	Coast of North Carolina	—0.29	11	*	7	3	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Off coast of Virginia.....	—0.29	11	*	6	3	
		10 p. m.	Off Long Island Sound...	—0.15	3	*	6	3	
X	10	7 a. m.	Off Massachusetts coast.	—0.05	3	*	6	3	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Off coast of Nova Scotia.	—0.16	2	*	6	3	
		10 p. m.	South of Newfoundland	—0.44	*	*	6	3	
XI	11	7 a. m.	North of Montana.....	—0.59	*	1	7	†	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	do.....	—0.52	1	†	7	†	
		10 p. m.	North of Minnesota.....	—0.42	*	†	1	†	
XII	12	7 a. m.	Northern Minnesota.....	—0.35	*	†	†	†	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	North of Lake Huron...	—0.14	*	†	†	†	
		10 p. m.	Upper Canada.....	—0.14	†	†	6	*	
XIII	13	7 a. m.	Gulf of Saint Lawrence.	—0.14	†	†	2	3	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Western New Mexico...	—0.37	†	†	4	3	
		10 p. m.	Northern New Mexico...	—0.37	†	†	4	3	
XIV	14	7 a. m.	do.....	—0.43	†	†	4	3	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Northwestern Texas.....	—0.40	15	3	†	5	
		10 p. m.	Indian Territory.....	—0.40	12	3	†	5	
XV	15	7 a. m.	Southeastern Kansas...	—0.30	14	12	†	5	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Central Missouri.....	—0.38	8	15	9	5	
		10 p. m.	Southern Wisconsin...	—0.34	6	15	9	5	
XVI	16	7 a. m.	Southern Michigan.....	—0.45	2	24	16	5	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	East of Lake Huron.....	—0.59	2	21	16	5	
		10 p. m.	Lower Canada.....	—0.72	4	12	22	5	
XVII	17	7 a. m.	North of Maine.....	—0.81	7	8	25	*	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	New Brunswick.....	—0.84	4	3	10	*	
		10 p. m.	Gulf of Saint Lawrence.	—0.75	*	†	12	10	
XVIII	18	7 a. m.	Southern Michigan.....	—0.55	11	5	16	6	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Lake Erie.....	—0.57	10	2	16	6	
		10 p. m.	Northern Virginia.....	—0.49	10	†	9	10	
XIX	19	7 a. m.	Southeast Virginia.....	—0.54	8	†	9	10	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Off Virginia coast.....	—0.65	7	†	13	9	
		10 p. m.	Off Massachusetts coast.	—0.49	3	*	17	3	
XX	20	7 a. m.	Nova Scotia.....	—0.66	3	*	17	3	From this region the depression moved thence eastward to the Atlantic.
		3 p. m.	Gulf of Saint Lawrence	—0.76	3	*	17	3	
		10 p. m.	do.....	—0.76	3	*	17	3	

Table of low-pressure areas—Continued.

Number of area.	Date.	Hour of observation.	Location of central area of low pressure.	Barometric departure.	No. of stations reporting precipitation.				Remarks.
					NE. quadrant.	SE. quadrant.	SW. quadrant.	NW. quadrant.	
VII	15	10 p. m.	North of Montana.....	Inches. —0.31	†	†	†	†	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Central Montana.....	—0.45	†	†	†	†	
		3 p. m.	Southern Wyoming Ter.	—0.45	3	†	†	3	
VIII	16	10 p. m.	Western Nebraska.....	—0.44	†	†	†	†	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Eastern Nebraska.....	—0.37	7	†	†	8	
		3 p. m.	Western Illinois.....	—0.45	15	6	3	14	
IX	17	10 p. m.	Northern Indiana.....	—0.34	9	6	7	13	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Lake Erie.....	—0.31	10	6	7	12	
		3 p. m.	Lower Canada.....	—0.26	9	14	23	9	
X	18	10 p. m.	Northern Vermont.....	—0.21	7	3	27	6	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Gulf of Saint Lawrence.	—0.29	†	†	31	†	
		3 p. m.	North of Montana.....	—0.52	†	†	4	†	
XI	19	10 p. m.	North of Dakota.....	—0.59	†	†	2	†	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Northern Minnesota.....	—0.67	†	†	2	5	
		3 p. m.	North of Lake Superior	—0.54	†	7	6	†	
XII	20	10 p. m.	North of Lake Huron...	—0.35	†	3	†	†	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Lower Canada.....	—0.17	†	†	†	†	
		3 p. m.	Mouth St. Lawrence R.	—0.07	†	†	†	†	
XIII	21	10 p. m.	Coast of Washington T.	—0.19	1	2	3	3	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Washington Territory...	—0.36	1	†	3	3	
		3 p. m.	Western Montana.....	—0.41	2	†	†	4	
XIV	22	10 p. m.	Eastern Wyoming Ter.	—0.20	2	†	†	4	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Western Nebraska.....	—0.16	4	3	2	3	
		3 p. m.	Northern Texas.....	—0.28	8	4	†	5	
XV	23	10 p. m.	Southern Indian Ter...	—0.39	13	3	†	11	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Northern Arkansas.....	—0.33	21	3	†	6	
		3 p. m.	Southwestern Ohio.....	—0.40	13	11	22	6	
XVI	24	10 p. m.	Lake Ontario.....	—0.54	11	5	27	6	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Upper Canada.....	—0.61	4	5	32	*	
		3 p. m.	Mouth St. Lawrence R.	—0.61	*	3	25	*	
XVII	25	10 p. m.	Southern Wyoming Ter.	—0.33	5	†	†	5	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Southeastern Colorado...	—0.33	7	†	†	4	
		3 p. m.	Northwestern Texas.....	—0.39	12	†	†	6	
XVIII	26	10 p. m.	Southwestern Arkansas	—0.23	10	†	†	11	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Central Illinois.....	—0.22	15	†	†	17	
		3 p. m.	Northern Michigan.....	—0.20	†	10	11	4	
XIX	27	10 p. m.	Lake Huron.....	—0.24	3	19	18	†	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Lower Canada.....	—0.33	7	14	21	†	
		3 p. m.	Upper Canada.....	—0.27	3	7	25	*	
XX	28	10 p. m.	Mouth St. Lawrence R.	—0.33	*	5	19	*	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	South of Newfoundland	—0.10	*	†	13	*	
		3 p. m.	Northern Colorado...	—0.39	3	9	3	6	
XXI	29	10 p. m.	Northwestern Texas.....	—0.33	10	12	3	5	A description of this depression throughout the remainder of its course will appear in the Review for January, 1887.
		7 a. m.	Northern Louisiana...	—0.35	32	5	†	14	
		3 p. m.	Tennessee.....	—0.37	26	10	10	15	
XXII	30	10 p. m.	West Virginia.....	—0.30	22	8	17	10	From this region the depression moved thence eastward to the Atlantic.
		7 a. m.	Central Pennsylvania...	—0.49	14	6	16	15	
		3 p. m.	do.....	—0.49	14	6	16	15	

\* No reports.

† None.

The following notes from observers relate to the weather conditions prevailing during the presence of low area number ii:

Saint Vincent, Minnesota: rising barometer and fresh northwesterly winds prevailed during the early morning of the 1st; the wind gradually increased in force until 9.50 a. m. when a gale set in and continued until 7.55 p. m., attaining its maximum velocity, thirty-nine miles per hour from the north, at 11.45 a. m.

Milwaukee, Wisconsin: at 5.50 a. m. of the 1st a westerly gale set in and continued until 11.15 p. m.; maximum velocity, thirty-nine miles per hour, at 11.07 p. m. The temperature fell rapidly during the morning and remained low throughout the day; steadily rising barometer. During the night of the 1st-2d a westerly gale again set in and reached a velocity of thirty-four miles per hour. Between midnight and 1 a. m. of the 1st the steam barge "Maggie Marshall" and schooner "Arundel" were driven on the beach near Manistee, Michigan. Shortly after 1 a. m. of the 1st the schooner "Mineral State" went ashore at Jacksonport, Wisconsin, but was gotten off with only slight damage.

Port Huron, Michigan: light snow fell on the 1st from 7.35 a. m. until 3.45 p. m.; at 12.40 p. m. a westerly gale set in and reached its height, thirty-eight miles per hour, at 4.10 p. m. The gale continued throughout the night of the 1st-2d, and was accompanied by extremely cold weather, a fall of 22°.5 having occurred during the afternoon of the 1st.

Mackinaw City, Michigan: light snow began at 12.10 a. m. of the 1st and continued until the morning of the 2d, with rising barometer and falling temperature. A westerly gale set in at 8.50 a. m. and continued throughout the night, reaching at 10 p. m. a velocity of thirty-six miles per hour. On the 2d the wind blew hard from the northwest.

Chicago, Illinois: light snow fell at intervals during the 1st, with high southwest winds; maximum velocity, twenty-eight miles per hour, at 2.46 p. m. After 8 a. m. the weather began clearing, with falling temperature, attaining a minimum of —1°.0.

Buffalo, New York: the 1st was cloudy, with snow squalls at intervals; at 4.45 p. m. a westerly gale set in and continued until 7 p. m. of the 3d; maximum velocity, forty-four miles per hour, at 7.30 a. m. of the 2d.

Rochester, New York: cloudy weather, with snow, prevailed during the afternoon and night of the 1st, with brisk variable winds, increasing to high westerly, which attained the force of a gale at 11.15 p. m. and continued until 7.20 p. m. of the 2d; maximum velocity forty miles per hour.

Oswego, New York: snow began falling during the early morning of the 2d and continued until 6.30 p. m. of the 3d. The storm was accompanied by high westerly wind, which attained at 12.15 a. m. a velocity of thirty-one miles per hour. At 8 a. m. the wind shifted from west to northwest, and blew from the latter direction at the rate of thirty-three miles per hour at 3.40 p. m. Numerous reports from vessels indicate that the storm was more severe on the lakes than at this station; the schooner "Ariadne," Capt. Hugh McKay, from Toronto, Canada, for this port, laden with barley, was driven ashore in Mexico Bay, and lost, with part of the crew. The schooner "Ocean Wave" was driven ashore at Port Ontario at 2.30 p. m. of the 3d, but was gotten off with only slight damage.

The following notes from observers relate to the weather conditions prevailing along the Atlantic coast during the presence of low area number iii:

Pensacola, Florida: a heavy southeasterly wind set in during the early morning of the 4th, maximum velocity thirty-seven miles per hour. Light rain commenced at 10.30 a. m. and continued until 9.20 p. m. During the storm the Norwegian bark "Dagmar," lying alongside the wharf, was blown on her beam's end, but was righted without any serious damage. The bark "Flora" dragged her anchors and ran aground; the schooner "Wallace" was capsized, and several other vessels suffered slight damage.

Hatteras, North Carolina: heavy rain, with brisk northerly winds, occurred during the night of the 4-5th; heavy and light rain fell on the 5th, total precipitation for the thirty-six hours, 2.65 inches. At 4 p. m. of the 6th a northwesterly gale set in, reaching at 4.30 p. m. a maximum velocity of thirty-seven miles per hour. A second storm began at 11.15 p. m. and continued until 12.05 p. m. of the 7th, maximum velocity, thirty-one miles per hour, at 1.30 a. m.

Kitty Hawk, North Carolina: the 4th was cloudy, with high northeasterly winds, which attained at 5.30 p. m. the velocity of a gale, and reached at 6.15 and 10 p. m. a maximum velocity of forty miles per hour. Snow and rain fell during the night of the 4-5th and throughout the 5th; at the same time a heavy gale was blowing, attaining a velocity of forty-eight miles per hour at 2.30 a. m., 8.30, 9, and 9.30 p. m.

Smithville, North Carolina: rain began at 10.40 a. m. of the 4th and continued at intervals throughout the day. A northeasterly gale set in at 10.45 p. m., maximum velocity thirty-two miles per hour. The wind continued high during the 5th, and during the afternoon backed from ne. to n. and nw. The steam-tug "Howland" and the Norwegian bark "Elena" dragged their anchors during the storm, but no material damage was sustained by vessels in the harbor.

Baltimore, Maryland: heavy snow fell during the 4th and 5th to a depth of several inches; street cars kept up travel with considerable difficulty and all railroad trains arrived late. Light snow and rain fell during the 6th, with fresh northwesterly winds. Vessels arriving on the 5th, 6th and 7th reported a severe storm on Chesapeake Bay.

Atlantic City, New Jersey: light snow fell during the night of the 4-5th, and snow and sleet throughout the 5th. Brisk to high north and northeasterly winds prevailed on the 5th; maximum velocity, thirty-three miles per hour, at 1.50 p. m. The snow continued until 8.30 a. m. of the 6th, with high northerly winds all day; maximum velocity, thirty-six miles per hour, at 7.25, 8.10, and 11.20 p. m.

Block Island, Rhode Island: high northeasterly winds prevailed during the 5th, maximum velocity forty-eight miles per hour; the storm was accompanied by heavy snowfall, total depth for the day 8.8 inches. Sleet and light rain fell during the 6th, and the northeasterly gale of the previous day continued, attaining a velocity of fifty-one miles per hour.

Boston, Massachusetts: heavy snow began at 8.15 p. m. of the 5th and continued until 2.00 a. m. of the 6th. During the 5th the wind blew briskly from the northwest veering to northeast, highest velocity, twenty-seven miles per hour from the northeast, at 9 p. m.; total snowfall 9.5 inches. On the 6th the wind blew a gale from the north and northeast. Light snow, with northeasterly gale, prevailed during the 7th, maximum velocity thirty-six miles per hour. The heavy fall of snow which accompanied this gale seriously interfered with travel on the streets. The storm did some slight damage to vessels in the harbor; a scow used for dredging purposes was torn from its fastenings and broken up on the beach.

#### NORTH ATLANTIC STORMS DURING DECEMBER, 1886.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that have appeared over the north Atlantic Ocean during the month are determined, approximately, from international simultaneous observations furnished by captains of ocean steamships and sailing vessels; abstracts of ships' logs and other data collected by the Signal Service agencies at the ports of New York, Boston, and Philadelphia; reports received through the co-operation of the "New York Herald Weather Service;" abstracts of ships' logs furnished by the proprietors of the "New York Maritime Register,"

and from other miscellaneous data received at this office up to January 21, 1887.

Ten depressions are traced, of which five passed northeastward over Newfoundland; four apparently developed over the ocean to the southward of Nova Scotia, two of which are traced south of the fortieth parallel; one first appeared over mid-ocean in about N. 55°, and one is given a probable easterly course in the vicinity of the Azores.

The depression traced as number 1 occasioned storms of almost unprecedented violence over the British Isles during the 7th and 8th, and exhibited the lowest barometric readings ever recorded in London and Liverpool. This storm first appeared south of Nova Scotia on the 2d, and, pursuing a generally northeast course, was central in the vicinity of Aberdeen, Scotland, at noon, Greenwich mean time, of the 8th. Number 2 is first charted in N. 55°, W. 27° under date of the 2d, from which position it circled southeast and northeast, disappearing over Ireland after the 3d. Number 3 was a continuation of an area of low pressure which passed into the Atlantic Ocean from the Gulf of Mexico. This storm is traced northeastward across the Atlantic Ocean to the northern portion of Scotland by the 12th, after which date it disappeared beyond the region of marine observation. Number 4 developed south of Nova Scotia on the 6th, and, moving rapidly northeast, disappeared over mid-ocean after the 7th.

Number 5 passed northeast over northern Newfoundland during the night of the 11th; after reaching the twenty-fifth meridian the depression moved southeast and passed to the south of Ireland beyond the region of observation after the 16th. Number 6 moved east over Newfoundland during the night of the 14th, and apparently moved southeast after passing the forty-fifth meridian. Number 7 was, possibly, a continuation of number 6, and is given a probable track north of the Azores to the fifteenth meridian by the 18th, after which date its course cannot be traced, owing to an absence of reports. Number 8 appeared over the ocean south of Nova Scotia on the 20th, and, moving northeast, disappeared east of Newfoundland after the 21st. Number 9 passed northeast from the northern extremity of Florida and disappeared in the direction of the British Isles after the 22d. Number 10 is first charted south of Newfoundland, in N. 40°, under date of the 27th, and moved northeast until the 29th, after which it passed to the northward of the fifty-fifth parallel.

The first decade of the month was characterized by a succession of terrific west and northwest gales, accompanied by high seas; the disturbances being more severely felt in European waters. During this period the barometric pressure was high over and to the southwestward of the Azores, and the depressions were deflected to a northeast course after leaving the North American coast. During the second decade the weather was stormy and unsettled over the ocean east of the twentieth meridian, and gales of considerable severity were frequent over and in the vicinity of the British Isles.

The area of high pressure which occupied the ocean in the neighborhood of the Azores during the first decade gave way and apparently moved southwestward, allowing a storm-area of considerable energy to pass eastward in about N. 40° from the 16th to the 18th. From the 22d to the 24th, inclusive, the pressure was high south of Newfoundland and Nova Scotia, while during the same period, and until the 28th, low pressures and frequent storms of marked severity were experienced off the west coast of Europe. From the 25th to the 30th the weather conditions were unsettled over the ocean in the vicinity of Newfoundland and Nova Scotia. The month closed with relatively fair weather prevailing off the American and European coasts, and a depression of slight depth central over mid-ocean.

For December, 1885, the paths of ten areas of low pressure were traced, of which four were continuations of low areas which entered the Atlantic Ocean from the Gulf of Saint Lawrence; one was a continuation of an area of low pressure which developed near the coast of Florida; one developed in



about N. 42°, W. 59°, and the remaining depressions apparently developed over the ocean east of the fortieth meridian and between N. 45° and 55°. The general direction of movement of the storm-centres was northeasterly or east-northeasterly. The general character of the weather over the north Atlantic was unsettled. During the first seven days the pressure was generally low; about the 7th an area of high pressure formed over mid-ocean and continued, with slight fluctuations, until the 13th, when it was replaced by areas of low pressure over the ocean east of the fortieth meridian. The pressure continued comparatively low over mid-ocean from the 13th to the 19th, while areas of high pressure appeared off the American and European coasts. During the balance of the month the pressure was generally high from the Banks to the European coasts, and low near the coast of the United States.

As compared with the corresponding month of previous years the weather over the north Atlantic during December, 1886, was exceptionally severe over the eastern portion of the ocean, and the barometric pressure exhibited over the British Isles during the storm of the 7th and 8th was probably the lowest ever recorded. Irregular reports are at hand relative to a severe storm which prevailed over England and France on the 26th, but data at present available fails to indicate the presence of a depression over the ocean immediately prior, or subsequent to, that date.

The following are brief descriptions of the depressions traced:

1.—The development of this depression was probably subsidiary to an area of low pressure which passed northeastward over New England and Nova Scotia during the 2d and 3d. The storm, however, possessed individual strength, and on the 2d, when central south of Nova Scotia, exhibited pressure about 29.50 (749.3).

On the morning of the 3d the storm was central off the southeast extremity of Newfoundland, with fresh gales to the southward and eastward; during the next twenty-four hours the depression moved rapidly northeast to N. 55°, W. 38°, after which it is given a probable northeasterly course until the 7th, when the centre of depression was apparently central northwest of the British Isles. By noon of the 8th the storm-centre had passed to the vicinity of Aberdeen, Scotland, and the fall of the barometer over England was probably without a parallel in the history of that country; the barometric minima reported being 27.45 (697.2) at the Orme's Head, and 27.48 (698.0) at Liverpool. At Leith, Scotland, the barometer fell with great rapidity during the day, reaching 27.65 (702.3) at nineteen hours thirty minutes. This is reported as being by far the lowest reading of the barometer that has occurred at Leith since January 26, 1884, on which date the lowest reading ever made at that place was recorded at 10 p. m., viz., 27.45 (697.2).

The following special reports have been rendered relative to this depression:

Capt. F. Manly, commanding the s. s. "Borderer," reports a heavy westerly gale at Halifax, Nova Scotia, from the 2d to the 4th. Capt. John Schade, of the s. s. "Polaria," reports a whole nw. gale from the 2d to 4th; lowest barometer, 29.47 (748.5), at 8 p. m. of the 2d, in N. 42° 18', W. 62° 22'. Capt. W. Tyson, of the s. s. "Holland," reports a strong gale from the 2d to 4th; lowest barometer, 29.35 (745.5), at noon of the 2d, in N. 41° 18', W. 66° 15'. The gale commenced very suddenly in a squall from wsw., with furious rain, the weather having been unsettled and barometer gradually falling for forty-eight hours previous; the wind shifted almost immediately to w. by n., blowing a strong gale with heavy squalls, attended with snow, for about twenty-four hours, then gradually moderated. Capt. B. Gleadell, of the s. s. "Germanic," reports a whole gale from the 2d to 4th; lowest barometer, 29.47 (748.5), at midnight of the 2d, in N. 43° 30', W. 57° 42'; gale set in from s. and veered to nw., with heavy squalls, hail, and sleet.

Mr. F. Wilson, observer on the s. s. "Bulgarian," Capt. E. Parry, commanding, reports: "On the 7th, 8th, and 9th, be-

tween N. 50° 55', W. 16° 0', and N. 50° 15', W. 18° 30', experienced a very heavy gale; at about 2.30 p. m. on the 7th, wind a moderate gale from the w.; then backed to ssw. and increased in force, hauling more to the westward, until at midnight it was blowing a terrific gale, with squalls of hurricane force and tremendous seas; at 3 a. m. of the 8th a sea struck the ship on the starboard side amidships, breaking up two boats and doing other damage; 8 a. m., wind wnw., settling into a steady gale with terrific hail squalls, accompanied with heavy and frequent lightning; at noon of the 9th the gale moderated, squalls became less frequent, though still heavy." Capt. J. G. Braes, of the s. s. "State of Nebraska," reports a hurricane from wnw. backing to sw., and veering to nw. and n. from the 7th to the 9th; lowest barometer, 28.49 (723.6), at 8 p. m. of the 7th, in N. 55° 1', W. 18° 52'. The storm was accompanied by tremendous head seas, and terrific hail and snow squalls were encountered during entire passage.

Chief Officer E. C. King, of the s. s. "Umbria," Capt. W. McMickan, commanding, reports the storm of the 7th and 8th as being of exceptional violence the wind at times blowing with hurricane force, with a tremendous sea running; lowest barometer, 29.16 (740.7), at 2 p. m. of the 7th, in N. 49° 45', W. 31° 50'. The wind set in from west by south and veered to nw. Capt. J. H. Malet, of the s. s. "Buffalo," reports a whole westerly gale from the 6th to 8th; lowest barometer, 29.20 (741.7), at 3 p. m. of 7th, in N. 50° 0', W. 25° 30'. The s. s. "England" had a strong gale on the 7th and 8th; wind veered from w. by s. to nw.; lowest barometer, 29.29 (744.0), at 4 p. m. of the 7th, in N. 50° 16', W. 28° 30'. Captain Franguel, of the s. s. "La Bourgogne," reports a westerly storm attaining hurricane force from the 5th to 13th; lowest barometer, 29.10 (739.1), at 4 p. m. of the 7th, in N. 50° 6', W. 27° 13'. The storm was accompanied by a tremendous high and short chopping sea from nw. and sw.

The following half-hourly readings, made by Messrs. J. Bolam and G. Redpath, observers at Leith Navigation School, mark the progress of the depression over that place:

Hours.	Minutes.	Inches.	Millimeters.	Hours.	Minutes.	Inches.	Millimeters.
6	0	28.463	722.4	14	30	27.824	706.6
6	30	28.381	720.8	15	0	27.796	706.1
7	0	28.286	718.6	15	30	27.770	705.3
7	30	28.220	716.8	16	0	27.749	704.1
8	0	28.168	715.5	16	30	27.721	704.1
8	30	28.128	714.5	17	0	27.707	703.8
9	0	28.111	714.0	17	30	27.690	703.3
9	30	28.081	713.2	18	0	27.675	702.8
10	0	28.060	712.7	18	30	27.664	702.6
10	30	28.032	711.9	19	0	27.660	702.6
11	0	28.011	711.4	19	30	27.651	702.3
11	30	27.985	710.7	20	0	27.656	702.6
12	0	27.959	710.2	20	30	27.654	702.6
12	30	27.936	709.4	21	0	27.671	702.8
13	0	27.909	708.9	21	30	27.693	703.3
13	30	27.889	708.4	22	0	27.707	703.8
14	0	27.855	707.4				

\* Lowest.

The following extract relative to this remarkable storm, from the Liverpool "Courier," of December 11, 1886, is furnished by Third Officer J. H. Mills, of the s. s. "Aurania," Capt. W. H. P. Hains, commanding:

A storm of great severity has prevailed in Liverpool, Birkenhead, and district. On Tuesday evening, the 7th, a strong gale sprang up in this neighborhood, and as the night wore on the storm increased in intensity. Heavy showers of hail, sleet, and rain fell at frequent intervals, and these continued all Wednesday, the 8th. There were occasional lulls in the violence of the storm, but they were only of short duration, and last night the wind was blowing very strong. No serious casualties have been reported. At nine on Wednesday evening, although it was only a thirteen feet and ten inches tide, the force of the gale drove the water near the stages to a depth of twenty feet. Shortly after ten o'clock the violence of the wind, which came principally from the northwest, abated considerably, but the rain squalls continued with fury. The New Brighton boats stopped running in the evening, and the traffic to the southern ferries was also suspended.

The following extraordinary fall of the barometer is recorded by Mr. Wood, optician, Lord street: "The fall in the barometer on Wednesday afternoon has been, as far as our knowledge goes, unparalleled, reading at 3.30 o'clock the extraordinary figures 27.880 (708.1), and still falling. We have looked back over our record of past years as far as the year 1840, and find the fol-

lowest nearest approaches to to-day's barometer: November 3, 1841, 28.350 (720.1); May 1, 1858, 28.105 (713.7); January 6, 1863, 28.345 (719.8); March 24, 1872, 28.140 (714.7)."

At sunset in the evening the barometer was observed to have fallen at the Orme's Head, to 27.450 (697.2), whilst in Liverpool it stood at 27.480 (698.0). This fall in the barometer is certainly unparalleled in the history of Liverpool, and many nautical men are of opinion that it has never been equalled in any part of the world.

Capt. R. Bussius, of the s. s. "Werra," had a whole gale from ssw., veering to nw., from the 8th to the 10th; lowest barometer, 28.30 (718.8), at midnight of the 8th, in N. 52° 50', E. 3° 0'. Capt. F. S. Land, of the s. s. "City of Berlin," reports a hurricane on the 8th while off Waterford in the Irish Channel; lowest barometer, 28.18 (715.8), at 4 a. m. Wind veered from wsw. to w. and wnw., and backed to wsw., and the storm continued until the 12th. The bark "Saint Patrick," on the 9th, in N. 42° 45', E. 5° 27', encountered a heavy ssw. gale, which carried away fore, main, and mizzen topsails, stay sail and jib; shifted cargo to port side and stove one boat; shipped much water.

Capt. J. C. Jamison, commanding the s. s. "Rhyndland," reports: "8th, at 11.15 a. m., in N. 50° 18', W. 17° 34', a heavy gale from wnw., with a fierce hail squall, during which a large meteor burst with a loud report between the fore and main masts about twenty feet above the bridge, emitting a strong, sulphurous smell, and covering the ship with a shower of sparks." Capt. E. Smit, of the s. s. "Pieter de Coninck," reports a whole gale from ssw., veering to nw., during the 8th and 9th; lowest barometer, 28.53 (724.6), at 6 a. m. of the 9th, in N. 50° 20', W. 0° 10'. Capt. R. T. Jones, of the s. s. "Galileo," reports a hurricane from sw., veering to nw.; lowest barometer, 28.34 (719.8), from noon to 4 p. m. of the 8th, in N. 49° 41', W. 0° 5'. Capt. J. Glasspoole, of the s. s. "Thales," reports: "7th, p. m., barometer fell very fast and wind backed to ssw.; barometer falling at the rate of one-tenth inch an hour for five hours; 8 p. m., wind increased to heavy gale; midnight, terrific gale and furious squalls from west, with much hail; 8th, 7.30 a. m., in N. 51° 0', W. 8° 30', very heavy gale from wnw.; tremendous sea broke on board, smashing wheel and after house, and gutting the saloon and captain's and officers rooms; barometer smashed and thermometer washed overboard; force of wind 12 and mountainous sea. The chief officer was washed along deck and had both legs broken; provisions, and captain and officers' effects, destroyed and washed overboard. At midnight of the 8th the weather began to moderate, with wind wnw."

Mr. H. Runton, observer, on the s. s. "Galileo," Capt. R. S. Jones, commanding, reports: "8th, encountered a strong sw. wind, accompanied with high, head sea; 2 a. m., wind increased to a gale, with falling barometer; sea increasing and the deck constantly flooded; 4 a. m., Wolfe Rock abeam, distance six miles; 8 a. m., strong, unsteady westerly gale; very high and dangerous sea; noon, wind still increasing, with violent squalls of hail, rain, and sleet; 4 p. m., wind increased to a hurricane, with tremendous sea; wind w.; at this time we were nearest the centre of the storm; 8 p. m., strong gale, high sea, with violent squalls, which continued until the 9th, at 4 a. m., when wind went wnw., with high sea and rising barometer. The progressive motion of the storm-centre was apparently towards the east."

Mr. James Miller, observer, on the s. s. "Scandinavian," Capt. John Park, commanding, reports: "9th, 2 a. m., Lamlash abeam two miles; 3 a. m., clouds suddenly overspread the sky from the nw. and wind increased to a gale; 4 a. m., blowing a heavy gale from nnw.; 4.07 a. m., gale increasing to hurricane force; heavy seas, breaking and deluging the ship fore and aft, and, as wind was blowing a hurricane on the north coast of Ireland, bore up for Lamlash; 6 a. m., wind nnw., force 11; 8 a. m., wind nnw., force 10; 9 a. m., anchored in Lamlash harbor; noon, weather improving; 3.45 p. m., weighed anchor." Capt. A. McKay, commanding the s. s. "Catalonia," reports: "8th and 9th, in the George's Channel, during passage from Liverpool to Queenstown, encountered a terrific gale from the

w. and wnw. of such violence at times as to bring ship to a standstill; during the height of the gale the ship was completely enveloped in a mass of drifting spray and foam, obscuring everything from view beyond a half-ship's length, the sea running tremendously high."

2.—This depression appeared over the ocean, in about N. 55°, W. 27°, on the 2d, with pressure ranging below 29.70 (754.4), whence it passed southeast to N. 51°, W. 15° by the 3d, and then circled northeast over the British Isles. The depression was shallow and of slight energy throughout its course.

3.—This depression apparently developed off the New England coast and was central on the morning of the 6th south of Nova Scotia, with central pressure about 29.70 (754.4) whence it moved rapidly northeastward and disappeared over mid-ocean after the 7th, being probably drawn into the extended area of low pressure which extended from the British Isles westward over a considerable portion of the ocean.

The following special reports refer to this depression:

Second Officer Francis Potts, of the s. s. "British Crown," Capt. Archibald Smith, commanding, reports a fresh gale, veering from s. by e. to n. by e., on the 6th; lowest barometer, 29.65 (753.1), at 5 p. m., in N. 46° 15', W. 54° 20'. The gale was accompanied by heavy rain. Captain Yungst, of the s. s. "Ems," reports a whole gale on the 5th and 6th from ese., veering to s., w., and ne.; lowest barometer at 2 a. m. of the 6th, in N. 40° 45', W. 68° 0'. Second Officer W. Barton, of the s. s. "British King," Capt. John Kelly, commanding, reports a fresh to strong gale, from se., veering to w. and ne., from the 5th to 7th; lowest barometer, 29.74 (755.4), at 4 a. m. of the 6th, in N. 40° 30', W. 67° 0'.

4.—This depression was a continuation of an area of low pressure which entered the Atlantic Ocean off the north coast of Florida and passed northeast over Newfoundland by the 8th. On the 9th the storm was central in about N. 54°, W. 39°, with evidence of great energy, and central pressure ranging to about 29.30 (744.2); by the 10th the depression had moved slowly northeast to W. 32°, where pressure ranging to about 28.60 (726.4) was shown; during the next twenty-four hours the storm-centre passed eastward to W. 17°, with an apparent slight decrease in pressure; at noon (Greenwich mean time) of the 12th the centre of depression had advanced eastward to the northern portion of Scotland, with a slight increase in central pressure, after which it disappeared to the eastward beyond the region of observation.

The following special reports give the general characteristics of the disturbances accompanying this depression.

The s. s. "Umbria," on the 9th, had a fresh westerly gale; lowest barometer, 29.56 (750.8), at 8 a. m., in N. 46° 30', W. 44° 25'. Capt. M. Fitt, of the s. s. "Virginian," reports a strong gale on the 8th and 9th; lowest barometer, 29.84 (757.9), on the 9th, in N. 43° 19', W. 55° 49'. The gale began on the 8th from se., force 7, and veered to s. with heavy rain, and increased at midnight to strong gale, w.; continuing throughout the 9th from sw. to w., and moderating at night. Chief Officer Falkner, of the s. s. "Kansas," Capt. W. Gleig, commanding, reports: "8th, in N. 45° 0', W. 52° 35', fresh sw. gale, barometer, 29.62 (752.3); gale began on the 8th from sse. and veered to sw., with snow-squalls; veered to w. and continued on 9th, in N. 44° 10', W. 57° 0'; then veered to nw. and moderated."

Chief Officer Potts, of the s. s. "Palestine," Capt. W. White-way, commanding, reports: "10th, in N. 51° 7', W. 25° 26' (at noon), a moderate gale began from wsw., increasing at 4 p. m. to heavy gale, w. by s., with hard squalls, high seas, and hail; barometer 29.00 (736.6) at 4 p. m.; gale continued, moderating slightly in the a. m. of the 11th, in N. 50° 59', W. 27° 44', and continued during the 11th, with squalls and high seas; barometer 29.05 (737.9) at 4 p. m., then rising."

Capt. W. H. Smith, of the s. s. "Sardinian," reports: "10th, in N. 54° 8', W. 21° 47' (at noon), at 4 a. m. the wind shifted suddenly to wnw. in a heavy squall, which rose to a strong gale; at 6.30 a. m. the wind moderated and backed to wsw."



On the 11th and 12th the s. s. "Catalonia" experienced a fresh gale from the wsw. veering to wnw., with terrific squalls and very high west sea; position at noon of the 11th N. 51° 13', W. 18° 45', at noon of the 12th, N. 50° 48', W. 21° 30'. The s. s. "Werra" on the 11th had a strong westerly gale; lowest barometer, 29.25 (742.9), at noon, in N. 51° 7', W. 13° 42'. Chief Officer Barwise, of the s. s. "Iowa," Capt. S. Waters, commanding, reports a fresh gale from sw., veering to wnw., on the 11th and 12th; lowest barometer, 29.02 (737.1), at 8 p. m. of the 11th; ship left Liverpool on the 11th; position at noon of the 12th, N. 51° 46', W. 7° 39'.

5.—This storm was a continuation of land depression number iv, which passed over the Gulf of Saint Lawrence and the northern portion of Newfoundland during the 11th; on the 12th the storm-centre had advanced northeast to about N. 54°, W. 40°, with strong gales over a considerable area; by the 13th the centre of depression had moved to N. 57°, W. 27°, where pressure ranging below 29.00 (736.6) was exhibited; from this position the storm passed southeast to N. 53°, W. 18° by the 14th, and N. 50°, W. 13° by the 15th, when it moved eastward five degrees by the 16th, after which it passed northeastward beyond the region of observation. From the 13th to the 16th the depression possessed great strength, and had central pressure ranging below 29.00 (736.6).

The following are special reports received from shipmasters relative to the passage of this depression:

The s. s. "Werra," on the 13th, experienced a strong westerly gale; lowest barometer, 29.21 (741.9), at 4 a. m., in N. 49° 25', W. 24° 38'. Capt. T. L. Weiss, of the s. s. "Wells City," reports: "14th, noon, strong gale and heavy squalls from nw., barometer 29.15 (740.4); 4 p. m., hard gale and violent squalls, barometer 28.98 (736.1); 6 p. m., gale increased to force 11, violent squalls and tremendous sea; 8 p. m., squalls of hurricane force, black, overcast sky; 10 p. m., barometer 28.90 (734.0), sky partly cleared, and storm abated in twenty minutes to force 8; 11.20 p. m., sky again became overcast, barometer fell to 28.85 (732.8); midnight, in N. 51° 12', W. 18° 0', wind hauled to n., force 9; 15th, 3 a. m., gale had hauled to ne., force 10, barometer rising; barometer continued to rise during the 15th, and gale moderated from ene." Capt. R. Ringk, of the s. s. "Fulda," reports a whole w. to nw. gale on the 14th and 15th; barometer lowest on the 15th, in N. 49° 41', W. 15° 25'.

6.—This depression was a continuation of land area number v, which passed eastward over the Gulf of Saint Lawrence and Newfoundland during the night of the 14th. On the morning of the 15th the storm was central in N. 51°, W. 45°, with pressure ranging below 29.00 (736.6), after which it apparently passed southeast in the direction of the Azores.

The following special reports refer to this storm:

Capt. H. W. Brown, of the s. s. "Pontiac," reports a whole gale, from wsw., backing to s. by e., and shifting to wnw., during the 13th and 14th; barometer lowest at 11.30 a. m. of the 14th, in N. 35° 20', W. 55° 5'. Capt. G. D. Spicer, of the ship "Charles S. Whitney," reports a heavy gale on the 14th, commencing from the sw., in N. 40° 20', W. 50° 20' (at noon); gale began at midnight and continued four hours, blowing very hard, with heavy rain; lowest barometer 29.45 (748.0).

The s. s. "Aurania," on the 15th and 16th, had a whole gale from se., veering to w. and nw. and backing to wsw. and s.; lowest barometer, 29.45 (748.0), at midnight of the 15th, in N. 48°, W. 40°. The gale was accompanied by a very high nw. sea, very confused at times. Captain Traub, of the s. s. "La Champagne," reports a storm of force 11 on the 15th and 16th; wind set in from se. and shifted to nw.; lowest barometer, 29.49 (749.0), at 5 a. m. of the 16th, in N. 47° 15', W. 42° 30'. Capt. J. C. Jamison, of the s. s. "Rhyndland," reports a whole gale from the 14th to 16th; wind veered from se. to n.; lowest barometer, 29.22 (742.2), at 5.15 a. m. of the 15th, in N. 47° 10', W. 43° 11'. Third Officer Prager, of the s. s. "Ems," Capt. T. Yüngst, commanding, reports a heavy gale from sse., veering to nw. on the 15th, in N. 47° 10', W. 41° 30' (at noon).

The weather was fearful during the morning, with heavy seas from all directions, and heavy rain showers; lowest barometer 29.17 (741.0).

The s. s. "Bulgarian," on the 15th, between N. 48° 20', W. 41° 40' and N. 47° 20', W. 43° 21', had wind backing at 9 a. m. from nw. to sse.; wind quickly freshened until it blew a strong gale; at 3 p. m., during a few minutes' lull, and very heavy rain, the wind suddenly shifted to w. by s. and continued to increase in force to very heavy gale at midnight, with terrific hail squalls and very heavy sea. At 9 a. m. of the 16th a terrible sea broke partially over the bow and starboard side of the upper bridge, carrying away iron stanchions and rails and drove the stanchions through the wooden deck, stove in the wheel-house door, and caused other damage. (The upper bridge is twenty-five feet above the water.) At noon the gale was gradually moderating, with rising barometer. On the 15th, the s. s. "Catalonia," in N. 48° 56', W. 37° 47' (at noon), experienced a moderate gale from ese., veering to w. and nne.

Capt. C. Thomas, commanding the s. s. "Monte Rosa," reports: "On the 15th, in N. 49°, W. 45° (at noon), experienced the heaviest gale I have met since I first went to sea (now twenty-six years). The gale commenced at 7 a. m. from ese., with heavy sea and very heavy rain; the barometer commenced to rise as soon as the gale came on; at noon the wind hauled to w. and nw.; while going westward we had fearful weather and mountainous seas; the wind blew mostly in squalls, but from 3 a. m. to 6 a. m. of the 16th it blew a perfect hurricane. The gale continued twenty-four hours." Capt. H. Perry, commanding the s. s. "Britannic," reports: "15th, 6 a. m., barometer falling, wind se., increasing to a fresh gale, with rain; 9 a. m., barometer falling, wind suddenly shifted to sw. and increased to a strong gale; 11 a. m., barometer falling, wind veered to w., thick, rainy weather; noon, in N. 48° 32', W. 42° 25', barometer, 29.00 (736.6); 4 p. m., barometer rising, whole gale, with violent squalls and heavy westerly sea; 8 p. m., wind wnw., whole gale, dangerous sea; 11 p. m., whole gale nw., very dangerous wsw. and nw. seas; shipped a heavy sea, carrying away two boats and damaging engine house; 16th, gale moderating."

7.—This depression was, evidently, a continuation of number 6, and, approaching the Azores from the northwest, was central on the 16th in N. 43°, W. 33°, with pressure ranging below 29.50 (749.3); from this position it is given a probable south of east course to N. 39°, W. 15° by the 18th, after which date its course cannot be traced, owing to absence of reports. The storm was possessed of considerable strength throughout, but, owing to a scarcity of reports from the region through which it passed, its track and severity cannot be accurately determined.

Under the influence of a depression which was central off the New England coast on the morning of the 16th, and which passed northeast over Nova Scotia during that date, strong gales were experienced over the ocean to N. 40° and W. 60°.

8.—This depression was central on the 20th in N. 37°, W. 65°, whence it moved northeast and disappeared off the coast of Newfoundland after the 21st. The depression was not attended by disturbances of marked violence, and exhibited minimum pressure, about 29.80 (756.9), on the 21st.

9.—This depression apparently entered the ocean in the vicinity of the Strait of Belle Isle during the 20th, and is given a probable northeast track to about N. 56°, W. 40° by the 21st, from which position it is traced to N. 59°, W. 25° by the 22d, after which it disappeared to the southeastward, probably passing over Scotland into the North Sea. The storm apparently possessed great energy, but passed too far to the northward to cause serious disturbances south of the fiftieth parallel.

10.—This depression first appeared in N. 40°, W. 59° on the 27th, with strong gales and rain to the northward and northeastward, whence it moved rapidly northeast to N. 50°, W. 44° by the 28th, where pressure about 29.50 (749.3) was shown; passing northeast, the depression is traced to N. 54°, W. 38°

by the 29th, after which it disappeared to the northeastward beyond the region of observation.

The following special reports have been rendered relative to disturbances encountered within the area of this depression:

Capt. W. Abbott, of the s. s. "Marengo," reports: "27th, 4 p. m. to 28th, 2 a. m., experienced a hurricane in N. 44° 42', W. 51° 56'; wind veered from s. through sw. and w. to wnw; barometer lowest at 7 p. m. of the 27th." Capt. J. Uberweg, of the s. s. "Waesland," reports a whole northerly gale on the 27th; lowest barometer, 29.20 (741.7), at 8.30 p. m., in N. 44° 35', W. 56° 29'. The gale was accompanied by heavy rain. Capt. P. Slierendregt, of the s. s. "Leerdam," reports a whole gale from se., veering to wsw., during the 27th and 28th; lowest barometer, 29.30 (744.2), at 10 p. m. of the 27th, in N. 46° 50', W. 47° 35'. Capt. R. Wills, of the s. s. "British Queen," reports a whole gale to hurricane during the 27th and 28th; wind set in from ne. and veered to sse. at noon of the 27th, in N. 46° 24', W. 48° 8', and during p. m. to nw., from which direction it blew a hurricane, with violent squalls and mountainous seas; lowest barometer, 29.44 (747.8), from 10 to 11 p. m. of the 27th. Chief Officer Kinning, of the s. s. "Roman," Capt. D. Williams, commanding, reports a gale from sw., force 9, at 4 a. m. of the 27th, in N. 44° 29', W. 53° 0'; barometer 29.05 (737.9).

Capt. W. Rippeth, of the s. s. "Otranto," reports a hurricane on the 27th from sse., veering to nw.; lowest barometer, 29.64 (752.8), in N. 42° 18', W. 55° 41'. Third Officer J. H. Mills, of the s. s. "Aurania," Capt. W. H. P. Hains, commanding, reports: "27th, between N. 43° 16', W. 54° 45' and N. 43° 39', W. 53° 12', and between the hours of 8 p. m. and 12 midnight, Greenwich mean time, experienced a storm; wind shifted from s. to w. and nw., with thick mist and rain; for about two hours it blew a hurricane from the w. and abated about midnight; lowest barometer, 29.28 (743.7), at 8 p. m., and at midnight it had risen to 29.59 (751.6).

Capt. B. Gleadell, of the s. s. "Germanic," reports a strong gale from se. veering to nw. during the 27th and 28th; lowest barometer, 29.65 (753.1), at 4.15 a. m. of the 28th, in N. 48° 50', W. 40° 50'.

During the 30th the presence of a depression of considerable energy was indicated to the northward of the Banks of Newfoundland, but its course lay too far to the northward of the region of observation to allow of accurately locating its centre.

#### OCEAN ICE.

No-icebergs have been reported during the month.

In December, 1885, several icebergs were observed on the Newfoundland coast, and over the Banks during the latter portion of the month.

For December of the three preceding years no icebergs were reported.

#### FOG.

The following shows the limits of fog-areas encountered on the north Atlantic Ocean during December, 1886, as reported by shipmasters:

1st.—The s. s. "Fulda," from N. 45° 0', W. 51° 30' to N. 43° 0', W. 57° 0', had dense fog, continuing from 8 a. m. to midnight; winds southerly; barometer about normal.

8th.—The s. s. "Siberian" had dense fog from 1 a. m. to 3 a. m., in N. 43°, W. 62°; wind strong from e. to s.; barometer considerably below the normal.

17th.—The s. s. "Palestine" had dense fog from 8 a. m. to 11 a. m., in N. 45° 51', W. 51° 24'; winds southerly; pressure below the normal.

20th.—The s. s. "Cephalonia" had dense fog during p. m., in N. 45° 40', W. 48° 0'. The s. s. "Bavarian" had dense fog from 10 to 11 p. m., in N. 44° 01', W. 48° 51'; winds southerly; pressure about normal.

From above reports it will be seen that fog was encountered during the month over, and to the southwestward of, the Banks of Newfoundland, with southerly winds and barometric pressure about, or below, the normal. As in the preceding

month (November, 1886), the conditions favorable to the development of fog seemed to exist to the eastward of barometric depressions.

#### TEMPERATURE OF THE AIR.

[Expressed in degrees, Fahrenheit.]

The distribution of mean temperature over the United States and Canada for December, 1886, is exhibited on chart ii by the dotted isothermal lines; and in the table of miscellaneous data are given the monthly mean temperatures, with the departures from the normal, for the various stations of the Signal Service. On chart iv the departures from the normal temperature are illustrated by lines connecting stations of normal or equal abnormal values.

In northeastern Montana and in all districts, except the Rio Grande Valley, from the one hundred and fifth meridian eastward, the temperature of the air for the month has been decidedly lower than the average December; the departures are especially large in Dakota, Minnesota, the Missouri Valley, and the upper Mississippi valley, the mean temperature of the air at Signal Service stations within these districts averages 7°.7 below the normal; in Minnesota and eastern Dakota the month has been 10°.0 colder than the average December. In the Lake regions, the Ohio Valley, and Tennessee, the departures average about six degrees below the normal. From the one hundred and fifth meridian westward the temperature of the month has been above the normal; the larger departures within this area occur in Washington Territory, Oregon, Idaho, and Nevada, where they range from 5°.7 at Boise City, Idaho, to 4°.4 at Olympia, Washington Territory. It is worthy of note in this connection that the area of greatest departure below the normal coincides with the area of maximum pressure.

The following are some of the most marked departures from the normal temperature at Signal Service stations:

Above normal.		Below normal.	
	°		°
Denver, Colorado.....	6.5	Moorhead, Minnesota.....	11.1
Boise City, Idaho.....	5.7	Huron, Dakota.....	10.6
Roseburg, Oregon.....	5.4	La Crosse, Wisconsin.....	10.4
Fort Grant, Arizona.....	5.4	Bismarck, Dakota.....	10.0
Winnemucca, Nevada.....	5.1	Davenport, Iowa.....	9.8
Helena, Montana.....	4.9	Dubuque, Iowa.....	9.6
Fort Davis, Texas.....	4.8	Duluth, Minnesota.....	7.6
Portland, Oregon.....	4.6	Keokuk, Iowa.....	7.4

In the following table are given the mean temperatures for the several geographical districts, with the normals and departures, as deduced from Signal Service observations:

Average temperatures for December.

Districts.	Average for December, Signal-Service observations.		Comparison of Dec., 1886, with the average for several years.
	For several years.	For 1886.	
	°	°	°
New England.....	30.4	27.3	- 3.1
Middle Atlantic States.....	36.9	32.0	- 4.9
South Atlantic States.....	48.6	45.5	- 3.1
Florida Peninsula.....	61.4	58.1	- 3.3
Eastern Gulf States.....	49.9	46.0	- 3.9
Western Gulf States.....	50.0	46.8	- 3.2
Rio Grande Valley.....	60.1	61.1	+ 1.0
Tennessee.....	41.4	35.2	- 6.2
Ohio Valley.....	35.1	28.7	- 6.4
Lower Lake region.....	30.1	24.0	- 6.1
Upper Lake region.....	24.3	18.6	- 5.7
Extreme Northwest.....	10.2	2.7	- 7.5
Upper Mississippi Valley.....	28.0	20.6	- 7.4
Missouri Valley.....	23.4	15.4	- 8.0
Northern slope.....	22.4	23.6	+ 1.2
Middle slope.....	31.2	32.3	+ 1.1
Southern slope.....	41.6	43.6	+ 2.0
Southern plateau.....	43.1	47.3	+ 4.2
Middle plateau.....	32.4	36.8	+ 4.4
Northern plateau.....	30.5	35.2	+ 4.7
North Pacific coast region.....	44.2	45.7	+ 1.5
Middle Pacific coast region.....	49.4	51.0	+ 1.6
South Pacific coast region.....	55.5	57.0	+ 1.5



## RANGES OF TEMPERATURE.

The monthly, and the greatest and least daily, ranges of temperature, are given in the table of miscellaneous meteorological data.

The following are some of the greatest and least monthly ranges at Signal Service stations:

Greatest.	Least.
Fort Assinaboine, Montana..... 98.9	Astoria, Oregon..... 20.0
Bismarck, Dakota..... 80.9	Fort Canby, Washington Ter..... 31.3
Huron, Dakota..... 80.2	Cape Mendocino, California..... 31.5
Fort Maginnis, Montana..... 78.4	San Francisco, California..... 22.7
Fort Buford, Dakota..... 78.2	Tatoosh Island, Washington Ter..... 26.5
Poplar River, Montana..... 78.0	Key West, Florida..... 27.3

Table of comparative maximum and minimum temperatures for December.

State or Territory.	Station.	For 1886.		Since establishment of station.			
		Max.	Min.	Max.	Year.	Min.	Year.
Alabama.....	Mobile.....	69.0	22.9	78.8	1884	14.0	1880
Do.....	Montgomery.....	66.8	22.1	77.1	1884	8.0	1880
Arizona.....	Prescott.....	64.1	21.6	70.0	1881	18.0	1879
Do.....	Fort Apache.....	67.3	18.5	70.0	1881, 1882	8.0	1884
Arkansas.....	Fort Smith.....	63.8	7.7	80.0	1873	9.0	1876
Do.....	Little Rock.....	65.0	14.7	74.4	1880	6.0	1880
California.....	San Francisco.....	66.0	43.3	68.0	1878	34.0	1879
Do.....	San Diego.....	75.5	40.5	82.0	1874	32.0	1879
Colorado.....	Denver.....	64.8	1.4	74.1	1885	25.0	1876
Do.....	Pike's Peak.....	23.1	-8.6	30.0	1877	37.0	1878
Connecticut.....	New Haven.....	55.6	6.9	62.0	1875	9.5	1884
Do.....	New London.....	54.1	19.3	60.5	1879	7.5	1883
Dakota.....	Fort Buford.....	45.3	-32.9	59.3	1885	46.0	1879
Do.....	Yankton.....	49.0	-22.7	62.0	1875	34.0	1879
Delaware.....	Del. Breakwater.....	49.1	12.1	69.0	1881	1.0	1880
Do.....	Cape Henlopen.....	54.2	10.8	73.0	1873	13.0	1880
District of Columbia.....	Washington City.....	75.4	27.4	81.0	1875	19.0	1880
Florida.....	Jacksonville.....	82.5	55.2	88.0	1876	44.0	1876
Do.....	Key West.....	64.6	14.9	71.0	1879	1.0	1880
Georgia.....	Savannah.....	74.0	25.0	80.0	1875	15.0	1880
Idaho.....	Boise City.....	60.2	21.2	60.5	1885	7.3	1884
Illinois.....	Cairo.....	57.2	11.3	72.0	1875	7.0	1872
Do.....	Chicago.....	59.8	9.5	68.0	1875	23.0	1872
Indiana.....	Indianapolis.....	57.7	3.5	68.0	1875	15.0	1876
Indian Territory.....	Fort Sill.....	69.0	3.1	77.0	1880	2.0	1879, 1880
Iowa.....	Des Moines.....	50.4	-23.5	57.7	1883	19.0	1876, 79, 80
Do.....	Des Moines.....	54.2	-19.5	57.0	1883	18.2	1884
Kansas.....	Dodge City.....	63.0	-5.0	73.0	1875	15.0	1876
Do.....	Leavenworth.....	58.7	-10.4	72.0	1875	13.0	1872
Louisiana.....	New Orleans.....	72.4	27.0	78.0	1871, 1875,	20.0	1870, 1880
Do.....	Shreveport.....	72.0	20.2	79.0	1875	10.0	1880
Maine.....	Eastport.....	46.6	-9.0	54.0	1877	21.0	1884
Do.....	Portland.....	49.6	-4.0	59.0	1884	17.0	1872
Maryland.....	Baltimore.....	52.2	15.0	71.0	1881	3.0	1880
Massachusetts.....	Boston.....	54.9	6.0	66.0	1881	12.0	1883
Michigan.....	Detroit.....	51.8	-2.5	65.0	1875	24.0	1872
Do.....	Alpena.....	52.6	1.7	56.0	1875	15.0	1880
Minnesota.....	Duluth.....	42.0	-20.8	51.0	1883	34.0	1879
Do.....	Saint Paul.....	42.7	-23.7	56.0	1877	39.0	1879
Mississippi.....	Vicksburg.....	69.1	19.2	79.0	1873, 1875	12.0	1880
Missouri.....	Saint Louis.....	61.1	-2.8	74.0	1875	17.0	1872
Montana.....	Fort Benton.....	73.3	18.5	85.0	1885	59.0	1880
Do.....	Helena.....	55.6	-15.5	56.8	1885	40.0	1880
Nebraska.....	North Platte.....	57.0	-6.8	69.0	1885	27.0	1879
Do.....	Omaha.....	61.0	6.0	77.0	1877	17.0	1879, 1884
Nevada.....	Winnemucca.....	61.3	15.8	65.0	1878	20.0	1879
New Hampshire.....	Mount Washington.....	32.4	-25.2	43.0	1884	47.0	1876
New Jersey.....	Atlantic City.....	51.4	13.7	64.0	1877	7.0	1880
Do.....	Sandy Hook.....	68.5	18.5	75.0	1881	5.0	1880
New Mexico.....	Santa Fe.....	54.0	13.3	65.0	1878	13.0	1879
New York.....	Rochester.....	48.2	-4.1	70.0	1875	11.0	1871
Do.....	New York City.....	54.2	14.0	66.2	1881	6.0	1880
North Carolina.....	Charlotte.....	61.9	17.5	71.0	1884	5.0	1880
Do.....	Wilmington.....	69.2	22.2	78.0	1879	10.0	1880
Ohio.....	Cincinnati.....	60.4	-2.6	72.0	1875	8.0	1872
Do.....	Cleveland.....	52.6	0.3	68.0	1875	12.0	1872, 1880
Oregon.....	Portland.....	65.4	29.7	63.0	1875, 1880	3.0	1879
Do.....	Roseburg.....	65.8	31.5	65.0	1880	7.0	1879
Pennsylvania.....	Pittsburg.....	58.5	6.8	72.8	1885	9.0	1880
Do.....	Philadelphia.....	55.3	12.9	70.0	1873	5.0	1880
Rhode Island.....	Block Island.....	54.3	15.5	60.0	1884	3.2	1884
South Carolina.....	Charleston.....	71.8	24.8	76.0	1881	13.0	1880
Tennessee.....	Knoxville.....	57.7	6.4	75.0	1874	5.0	1880
Do.....	Memphis.....	66.0	17.0	74.0	1875	3.0	1876, 1880
Texas.....	Brownsville.....	79.6	26.5	92.9	1885	18.0	1880
Do.....	Fort Elliott.....	71.3	2.4	83.0	1880	10.0	1879
Utah.....	Salt Lake City.....	55.7	19.0	61.0	1874	10.0	1879
Virginia.....	Lynchburg.....	56.0	15.0	73.0	1873	5.0	1880
Do.....	Norfolk.....	66.1	19.8	73.0	1873, 1874,	6.0	1880
Washington Ter.....	Spokane Falls.....	57.2	14.4	57.1	1885	-17.8	1884
Do.....	Olympia.....	60.2	31.0	64.2	1885	8.0	1879, 1884
Wisconsin.....	La Crosse.....	48.0	-14.9	60.0	1877	-37.9	1872
Do.....	Milwaukee.....	47.6	-17.3	63.0	1877	-21.6	1884
Wyoming.....	Cheyenne.....	64.2	18.5	75.0	1875	-24.0	1879, 1880

## DEVIATIONS FROM NORMAL TEMPERATURES.

In the table below are given, for certain stations, as reported by voluntary observers, the normal temperatures for December for a series of years, the mean temperature for December, 1886, and the departures from the normal:

Station.	County.	Normal temperature for December.	Number of years.	Mean temperature for Dec., 1886.	Departure.
Arkansas.					
Lead Hill.....	Boone.....	37.9	5	32.5	-5.4
California.					
Fall Brook.....	San Diego.....	52.5	10	53.9	+1.4
Sacramento.....	Sacramento.....	46.2	21	47.3	+1.1
Connecticut.					
Middletown *.....	Middlesex.....	38.3	28	24.6	-3.7
New Haven *.....	New Haven.....	30.7	100	27.3	-3.4
Thompson *.....	Windham.....	27.7	30	24.0	-3.7
Illinois.					
Anna.....	Union.....	37.5	11	30.4	-7.1
Mattoon.....	Coles.....	30.6	6	25.0	-5.6
Peoria.....	Peoria.....	28.6	30	23.0	-5.6
Riley.....	McHenry.....	21.7	25	15.4	-6.3
Sycamore.....	De Kalb.....	24.1	6	17.0	-7.1
Indiana.					
Lafayette.....	Tippecanoe.....	26.6	7	22.5	-4.1
Logansport.....	Cass.....	28.0	32	24.2	-3.8
Mauzy.....	Rush.....	26.4	7	20.4	-6.0
Vevay.....	Switzerland.....	34.6	21	29.6	-5.0
Iowa.					
Monticello.....	Jones.....	21.5	33	14.2	-7.3
Muscatine.....	Muscatine.....	23.8	47	10.6	-13.2
Kansas.					
Independence.....	Montgomery.....	34.1	14	28.3	-5.8
Lawrence.....	Douglas.....	29.6	19	24.0	-5.6
Wellington.....	Sumner.....	30.8	8	28.3	-2.5
Yates Centre.....	Woodson.....	29.4	7	25.5	-3.9
Louisiana.					
Grand Coteau.....	Saint Landry.....	55.2	3	59.2	+3.0
Maine.					
Belfast *.....	Waldo.....	23.3	27	20.9	-2.4
Bridgton *.....	Cumberland.....	22.5	12	18.5	-4.0
Cornish *.....	York.....	22.7	29	20.0	-2.7
Gardiner *.....	Kennebec.....	22.4	51	23.3	+0.9
Orono *.....	Penobscot.....	20.8	18	18.1	-2.7
Michigan.					
Thornville.....	Lapeer.....	28.6	10	19.6	-9.0
Maryland.					
Fallston.....	Harford.....	33.3	16	28.6	-4.7
Massachusetts.					
Amherst *.....	Hampshire.....	26.7	49	25.6	-1.1
Cambridge *.....	Middlesex.....	29.1	04	27.4	-1.7
Fitchburg *.....	Worcester.....	25.7	30	23.7	-2.0
Lowell *.....	Middlesex.....	27.9	15	21.6	-6.3
New Bedford *.....	Bristol.....	31.9	75	29.9	-2.0
Somerset.....	Bristol.....	30.0	16	28.4	-1.6
Springfield *.....	Hampden.....	27.6	20	25.6	-2.0
Taunton *.....	Bristol.....	30.5	16	27.7	-2.8
Williamstown *.....	Berkshire.....	26.3	32	22.1	-4.2
Nevada.					
Carson City.....	Ormsby.....	36.4	7	40.8	+4.4
New Brunswick.					
Saint John *.....	Saint John.....	22.6	26	23.2	+0.6
New Hampshire.					
Concord *.....	Merrimac.....	26.3	19	23.7	-2.6
Hanover *.....	Grafton.....	20.7	25	16.1	-4.6
New Jersey.					
South Orange.....	Essex.....	29.7	17	29.8	+0.1
New York.					
Factoryville.....	Tioga.....	27.5	5	22.3	-5.2
North Volney.....	Oswego.....	25.5	19	21.5	-4.0
Palermo.....	Oswego.....	24.2	33	19.3	-4.9
Ohio.					
Wauson.....	Fulton.....	26.7	16	19.3	-7.4
Pennsylvania.					
Dyberry.....	Wayne.....	24.9	22	21.5	-3.4
South Carolina.					
Stateburg.....	Sumter.....	47.1	6	43.9	-3.2
Texas.					
New Utm.....	Austin.....	53.9	14	52.7	-1.2
Vermont.					
Lunenburg *.....	Essex.....	30.8	38	15.9	-14.9
Newport *.....	Orleans.....	20.2	12	15.6	-4.6
Strafford.....	Orange.....	21.1	12	17.3	-3.8
Virginia.					
Bird's Nest.....	Northampton.....	41.6	18	39.0	-2.6
Dale Enterprise.....	Rockingham.....	38.6	6	31.4	-7.2
Variety Mills.....	Nelson.....	36.9	10	30.6	-6.3
West Virginia.					
Helvetia.....	Randolph.....	33.6	10	28.9	-4.7
Wisconsin.					
Delavan.....	Walworth.....	19.8	3	15.8	-4.0

\* From the "Bulletin of the New England Meteorological Society."

The following notes on the temperature of December and the year 1886 are given by voluntary observers:

California.—Sacramento: the mean temperature of 1886, 59°.4, is 0°.7 below the average of the past twenty-one years.

Illinois.—Riley, McHenry county: the mean temperature of the present December, 15°.4, is lower, with the exception of that of 1872 and 1876, than that of any other December during the past twenty-five years; in that time the warmest December occurred in 1877, mean temperature, 37°.8; the coldest

in 1876, mean, 11° 1'. The mean temperature of 1886, 44° 8', is only 0° 2' lower than the normal of the past twenty-three years; in that time 1870 was the warmest year, mean temperature, 48° 1'; 1875 was the coldest, mean, 41° 4'.

Sycamore, DeKalb county: the mean temperature of 1886, 45° 2', coincides with the annual mean of the past five years. The temperature of the present December, 17° 0', is lower than that of any other December during the past six years; in that time the warmest December occurred in 1881, mean, 34° 8'.

Sandwich, DeKalb county: the mean annual temperature of the past thirty-five years is 47° 8', the mean of 1886 is 48° 7', being 0° 9' above the normal; the maximum temperature of the past thirty-five years is 105° 0', the minimum is -34° 0'; the maximum of 1886 is 99° 0', the minimum is -25° 0'.

Indiana.—Logansport, Cass county: the highest December temperature since the beginning of observations in 1854, 72° 0', occurred in 1875, the lowest, -22° 0', in 1872; the highest mean temperature for that month, 45° 0', occurred in 1877; the lowest, 14° 0', in 1872; greatest monthly range, 79° 0', in 1870; least monthly range, 38° 0', in 1857; the highest temperature during 1886, 103° 0', occurred July 7th, the lowest, -17° 0', January 10th; the mean temperature for the year is 51° 6'.

Vevay, Switzerland county: the three highest temperatures that have occurred in December during the past twenty-one years are 76° 0' in 1865, 78° 0' in 1875, 72° 0' in 1867; the three lowest are -11° 0' in 1880, -7° 0' in 1871 and 1876.

Iowa.—Muscatine, Muscatine county: the present December is the coldest that has occurred during the past forty-seven years; it is 13° 2' below the normal and 3° 3' below the mean of December, 1872, which is second to the present December in point of low temperature; the minimum temperature of the month, -26° 0', was reached but once before, viz., in 1872.

Monticello, Jones county: the mean temperature of the year, 45° 9', is 0° 4' below the normal of the past thirty-two years; during December since 1854 the maximum temperature, 64° 0', occurred in 1877; the minimum, -36° 0', in 1872; the warmest December mean temperature, 39° 5', occurred in 1877; the coldest mean, 8° 1', in 1859.

Kansas.—Lawrence, Douglas county: the following table, by Prof. F. H. Snow, furnishes a comparison with the eighteen preceding Decembers:

	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Mean temp.....	33.9	39.6	38.4	24.4	19.8	31.1	30.8	39.4	33.6	44.4
Max. temp.....	53.0	63.0	64.0	38.0	55.3	67.3	53.5	73.0	66.0	68.0
Min. temp.....	-16.0	4.0	-10.0	-6.0	-18.0	9.0	-3.0	0.0	-5.0	10.0

	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	Mean.
Mean temp.....	33.0	35.2	25.8	40.1	31.2	33.7	23.5	32.5	24.0	29.2
Max. temp.....	53.0	63.5	61.0	63.0	58.0	63.0	59.5	57.0	58.0	61.4
Min. temp.....	-6.0	-9.0	-12.0	18.0	-6.5	3.5	-6.5	-1.5	-6.0	-3.3

Maine.—Cornish, York county: during the past twenty-nine years the coldest December occurred in 1859, mean temperature, 14° 7'; the warmest in 1877, mean, 27° 5'.

Massachusetts.—Somerset, Bristol county: the mean temperature of 1886, 50° 2', is 0° 7' above the average of the past sixteen years.

Worcester, Worcester county: the mean temperature of 1886 was 45° 1' against 44° 0' and 45° 8' the two preceding years. The extremes of temperature were -0° 0', February 7th, which was the coldest day of the year (with a mean temperature of -4° 5') and 89° 0', on July 6th and 7th, the latter being the warmest day, with a mean temperature of 78° 7'. The extremes of temperature during the last half century are, the minimum, -18° 5', on February 8, 1861, and the maximum, 98° 0', on June 22, 1849. The coldest day during the period was February 5, 1855, when the extremes were -7° and -14°, with a mean temperature of -11° 2'. The warmest day during the same period was July 13, 1849, when the extremes were 78° and 95°, with a mean temperature of 89° 2'.

New York.—North Volney, Oswego county: during the past nineteen years the coldest December occurred in 1876, mean temperature, 18° 0'; the warmest in 1881, mean, 33° 7'; the mean temperature of 1886, 45° 1', is 0° 3' above the average of the past nineteen years.

Palermo, Oswego county: the highest December mean temperature during the past thirty-three years, 32° 1', occurred in 1881; the lowest mean, 16° 8', in 1880; the mean temperature of the year 1886, 42° 7', is 4° 2' below the average of the past thirty-three years; the highest yearly mean in that time, 51° 8', occurred in 1878.

Ohio.—Wauseon, Fulton county: during the past sixteen years the highest December mean temperature, 38° 8', occurred in 1877; the lowest, 17° 1', in 1872; the December extremes for the same period are 70° 0' in 1875 and -32° 4' in 1884; the mean temperature of the year 1886, 47° 4', is 0° 3' below the average.

Texas.—New Ulm, Austin county: temperature comparisons for December during the past fourteen years: highest mean, 60° 0', in 1875; lowest mean, 46° 1', in 1876; highest temperature, 80° 0', in 1875; lowest, 9° 0', in 1880.

Virginia.—Dale Enterprise, Rockingham county: the highest December mean temperature recorded at this place within the past six years, 51° 4', occurred in 1880; the lowest, 28° 4', in 1882. The table below gives the maxi-

mum, minimum, and annual mean temperature of each year from 1880 to 1886, inclusive:

Years.	Temperature.		
	Maximum of the year.	Minimum of the year.	Annual means.
1880.....	100	-17	55.4
1881.....	99	-13	55.9
1882.....	97	5	53.6
1883.....	98	0	55.0
1884.....	97	-3	53.2
1885.....	100	-10	53.2
1886.....	95	-12	55.7
Means.....	98	-7	54.6

Bird's Nest, Northampton county: during the past eighteen years the lowest December mean temperature, 32° 7', occurred in 1876.

Wytheville, Wythe county: during the past twenty-two years one December only, that of 1878, was colder than the present month.

Variety Mills, Nelson county: the mean temperatures of December, 1886 and 1876, were each 30° 3', and were lower than the mean of any other December in the past ten years; the highest mean in that time, 43° 3', occurred in 1879; the mean temperature for 1886, 52° 5', is 2° 7' below the average of the previous nine years, and it is also the lowest annual mean that has occurred in that time; 1877 and 1881 were the warmest, annual temperature for each, 56° 5'; the maximum temperature of the year 1886, 93° 0', occurred July 30th; the minimum, -15° 6', on February 5th.

West Virginia.—Helvetia, Randolph county: the mean temperature of the year, 48° 9', is 1° 4' below the average of the last ten years.

#### FROSTS.

Frost occurred in the various districts on the following dates:

*New England.*—1st to 31st.

*Middle Atlantic states.*—1st to 31st.

*South Atlantic states.*—1st to 12th, 14th to 31st.

*Florida Peninsula.*—3d, 6th, 7th, 8th, 15th, 16th, 17th, 20th, 21st.

*East Gulf states.*—2d to 8th, 13th, 14th, 16th, 17th, 20th to 23d, 25th, 27th.

*West Gulf states.*—1st, 2d to 7th, 9th, 14th, 15th, 16th, 18th to 22d, 24th to 27th, 31st.

*Rio Grande Valley.*—5th, 6th.

*Tennessee.*—1st to 11th, 13th to 31st.

*Ohio Valley.*—1st to 22d, 24th to 31st.

*Lower lake region.*—1st to 31st.

*Upper lake region.*—1st to 31st.

*Extreme northwest.*—1st to 31st.

*Upper Mississippi valley.*—1st to 31st.

*Missouri Valley.*—1st to 31st.

*Northern slope.*—1st to 31st.

*Middle slope.*—1st to 31st.

*Southern slope.*—1st to 16th, 19th, 24th to 22d to 29th, 31st.

*Southern plateau.*—1st to 9th, 11th to 31st.

*Middle plateau.*—1st to 31st.

*Northern plateau.*—1st, 2d, 4th to 7th, 10th, 11th, 12th, 14th, 15th, 18th to 21st, 23d, 28th, 29th, 31st.

*North Pacific coast region.*—1st to 6th, 9th, 10th, 12th to 15th, 20th to 24th, 27th.

*Middle Pacific coast region.*—1st to 5th, 10th, 13th, 14th, 15th, 21st.

*South Pacific coast region.*—11th, 22d.

#### ICE.

Ice formed in the southern parts of the country, as follows:

*Florida.*—Jacksonville, 6th, 7th, 16th, 17th; Archer, 6th, 7th, 16th, 21st; Duke, 6th, 7th; Pensacola, 5th, 6th.

*Georgia.*—Savannah, 3d, 16th.

*Louisiana.*—New Orleans, 5th; Shreveport, 16th, 20th.

*North Carolina.*—Hatteras, 3d; Charlotte, 2d, 3d.

*South Carolina.*—Charleston, 16th, 17th.

*Texas.*—Palestine, 2d; Corsicana, 4th to 7th, 12th, 25th, 27th, 28th.

#### TEMPERATURE OF WATER.

The following table shows the highest and lowest temperatures of water observed at the several stations; the monthly



ranges of water temperature; the average depth at which the observations were made; and the mean temperature of the air:

Temperature of water for December, 1886.

Station.	Temperature at bottom.		Range.	Average depth, feet and tenths.	Mean temperature of the air at station.
	Max.	Min.			
Alpena, Michigan d.....	30.7	28.6	2.1	10.4	19.9
Augusta, Georgia.....	49.6	37.2	12.4	8.0	42.6
Baltimore, Maryland.....	44.5	34.1	10.4	11.9	31.3
Block Island, Rhode Island.....	46.5	35.2	11.3	6.3	34.0
Boston, Massachusetts.....	34.0	32.2	1.8	13.8	23.6
Buffalo, New York.....	49.7	46.2	3.5	15.4	47.5
Canby Fort, Washington Territory.....	62.1	49.6	12.5	7.7	54.4
Cedar Keys, Florida.....	55.0	48.0	7.0	36.5	48.4
Charleston, South Carolina.....	49.5	29.7	19.8	3.1	36.4
Chincoteague, Virginia.....	33.2	32.0	1.2	7.9	25.0
Chicago, Illinois.....	36.0	32.0	4.0	13.4	25.3
Cleveland, Ohio.....	35.6	34.1	1.5	10.6	8.9
Detroit, Michigan d.....	64.2	53.6	10.6	13.8	56.2
Duluth, Minnesota.....	32.9	32.0	0.9	17.6	22.5
Escanaba, Michigan.....	59.0	51.6	7.4	18.0	52.8
Galveston, Texas.....	76.5	65.0	11.5	18.4	67.5
Grand Haven, Michigan f.....	36.6	32.8	3.8	9.3	22.6
Jacksonville, Florida.....	56.9	44.7	12.2	14.7	45.2
Key West, Florida.....	35.2	31.4	3.8	11.7	15.6
Mackinaw City, Michigan g.....	56.9	45.8	11.1	15.9	48.9
Macon, Fort, North Carolina.....	47.0	37.5	9.5	11.4	29.9
Marquette, Michigan h.....	45.3	34.8	10.5	14.9	30.8
Mobile, Alabama.....	46.3	29.8	16.5	16.3	37.7
New London, Connecticut.....	67.1	50.9	16.2	16.9	57.3
New York City.....	42.9	30.0	12.9	17.4	23.1
Norfolk, Virginia.....	47.9	44.2	3.7	52.6	45.5
Pensacola, Florida.....	52.6	51.7	0.9	37.5	53.1
Portland, Maine.....	53.8	42.5	11.3	10.3	48.5
Portland, Oregon.....					
Sandusky, Ohio d.....					
San Francisco, California.....					
Savannah, Georgia.....					
Toledo, Ohio d.....					

a Frozen from 2d to 6th and from 16th to 31st.

b Frozen, 5th to 10th and from the 17th to 31st.

c Frozen 5th, 6th, 7th, and from 27th to 31st.

d Frozen throughout the month.

e Frozen from 5th to 31st.

f Frozen from 27th to 31st.

g Frozen 2d, 3d, 4th, and from the 15th to 31st.

h Frozen from 18th to 24th and from 26th to 31st.

### PRECIPITATION.

[Expressed in inches and hundredths.]

The distribution of rainfall over the United States and Canada for December, 1886, as determined from the reports of about five hundred and eighty stations, is exhibited on chart iii.

The precipitation of December, 1886, is nearly normal in all parts of the country, except in the Gulf and south Atlantic states and along the Pacific coast. In the Gulf and south Atlantic states the precipitation of the month is largely below the normal; within these districts three stations only, Charlotte, New River, and Wilmington, North Carolina, show an excess of precipitation; at all other stations the monthly precipitation ranges from one-half to one-seventh of the normal. The average precipitation for December, 1886, at Signal Service stations in the east Gulf states is only one-half the normal, and in the west Gulf states the average is less than one-third of the normal. Along the coast of Washington Territory and Oregon very large departures in excess of the normal occur, and in California large deficiencies. The rainfall of the western part of Washington Territory and Oregon deserves special mention, several stations reporting over fifteen inches; at Neah Bay, Washington Territory, 30.70 inches of rain fell, and at Tatoosh Island, Washington Territory, 25.84, which is 14.82 in excess of the normal.

The following are some of the most marked departures from the normal precipitation at Signal Service stations:

Above normal.		Below normal.	
	Inches.		Inches.
Tatoosh Island, Washington Ter.....	14.82	Shreveport, Louisiana.....	4.81
Olympia, Washington Territory.....	4.19	Little Rock, Arkansas.....	4.08
Portland, Oregon.....	3.37	Vicksburg, Mississippi.....	3.91
Eastport, Maine.....	2.51	Los Angeles, California.....	3.41
Block Island, Rhode Island.....	2.08	Palestine, Texas.....	3.10
Coeur d'Alene, Idaho.....	1.94	San Francisco, California.....	2.86

### DEVIATIONS FROM AVERAGE PRECIPITATION.

The following table shows, for certain stations, as reported by voluntary observers, the average precipitation for the month of December for a series of years, the precipitation for December, 1886, and the departures from the average:

Station.	County.	Average precipitation for Dec.	Number of years.	Precipitation for Dec., 1886.	Departure.
		Inches.		Inches.	Inches.
Lead Hill.....	Arkansas.	4.78	5	1.51	- 3.27
Fall Brook.....	California.	2.42	10	0.30	- 2.12
Sacramento.....	San Diego.....	4.60	21	2.13	- 2.47
Canton *.....	Connecticut.	3.63	25	2.71	- 0.92
Hartford *.....	Hartford.....	3.65	15	4.04	+ 0.39
Middletown *.....	Middlesex.....	3.74	28	5.72	+ 1.98
Wallingford *.....	New Haven.....	4.18	28	6.77	+ 2.59
Anna.....	Illinois.	3.25	11	3.25	0.00
Mattoon.....	Union.....	3.21	6	1.88	- 1.33
Peoria.....	Coles.....	2.41	30	0.89	- 1.52
Riley.....	Peoria.....	2.00	20	1.13	- 0.87
Sycamore.....	McHenry.....	2.75	6	1.45	- 1.30
Lafayette.....	Indiana.	3.02	7	1.96	- 1.06
Logansport.....	Tippecanoe.....	4.52	32	0.85	- 1.67
Vevay.....	Switzerland.....	2.12	21	2.89	+ 0.77
Monticello.....	Iowa.	2.40	33	0.84	- 1.56
Independence.....	Kansas.	2.39	14	0.65	- 1.74
Lawrence.....	Montgomery.....	1.63	19	0.83	- 0.80
Wellington.....	Douglas.....	0.98	8	0.08	- 0.90
Yates Centre.....	Sumner.....	1.45	7	0.49	- 0.96
Grand Coteau.....	Louisiana.	6.76	3	3.26	- 3.50
Gardiner *.....	Maine.	3.70	48	4.68	+ 0.98
Orono *.....	Kennebec.....	3.98	18	6.38	+ 2.40
Fallston.....	Maryland.	3.52	16	4.22	+ 0.70
Cambridge *.....	Massachusetts.	3.71	46	5.04	+ 1.33
Chestnut Hill *.....	Middlesex.....	3.35	11	5.82	+ 2.47
Framingham *.....	Middlesex.....	3.47	12	5.17	+ 1.70
Lake Cochituate *.....	Middlesex.....	3.51	35	5.67	+ 2.16
Lowell *.....	Middlesex.....	3.25	62	4.94	+ 1.69
Lynn *.....	Essex.....	2.70	12	5.75	+ 2.99
Mystic Lake *.....	Middlesex.....	3.01	11	4.68	+ 1.67
New Bedford *.....	Bristol.....	4.12	74	6.78	+ 2.66
Somerset *.....	Bristol.....	3.24	16	5.54	+ 2.30
Springfield *.....	Hampden.....	3.51	39	3.76	+ 0.25
Waltham *.....	Middlesex.....	2.95	61	6.25	+ 3.30
Williamstown *.....	Berkshire.....	2.63	18	4.04	+ 1.41
Carson City.....	Nevada.	2.00	8	9.72	+ 1.28
Saint John *.....	New Brunswick.	4.67	26	6.81	+ 2.14
Concord *.....	New Hampshire.	2.87	30	3.30	+ 0.43
Hanover *.....	New Jersey.	2.08	21	1.99	- 0.09
South Orange.....	New York.	3.75	17	3.55	- 0.20
Factoryville.....	Ohio.	1.41	5	0.77	- 0.64
Palermo.....	Ohio.....	3.97	33	2.97	- 1.00
Wauseon.....	Pennsylvania.	2.32	14	3.07	+ 0.75
Dyberry.....	South Carolina.	2.54	18	1.32	- 0.22
Stateburg.....	Texas.	3.41	6	2.56	- 0.85
New Ulm.....	Vermont.	4.59	14	0.97	- 3.62
Lunenburg *.....	Essex.....	3.94	38	3.40	+ 0.54
Newport *.....	Orleans.....	2.93	12	2.81	- 0.12
Stratford.....	Orange.....	3.20	12	2.70	- 0.50
Bird's Nest.....	Northampton.....	3.70	18	5.25	+ 1.55
Dale Enterprise.....	Rockingham.....	3.17	6	4.15	+ 0.98
Variety Mills.....	Nelson.....	3.77	8	3.06	- 0.71
Wytheville.....	Wythe.....	2.94	22	3.35	+ 0.41
Helvetia.....	West Virginia.	4.51	10	4.57	+ 0.06

\* From the "Bulletin of the New England Meteorological Society."

The following notes on the precipitation of December and the year 1886 are given by voluntary observers:

Illinois.—Riley, McHenry county: during the past twenty-six years the December precipitation was the greatest in 1863, total for month, 4.16; it was least in 1874, total, 0.48; during 1886 rain fell on eighty-one days, snow on forty-three days; total precipitation of the year, 31.24, which is 2.94 below the average of the past twenty-five years; in that time the largest annual precipitation occurred in 1881, total, 47.22; the least in 1874, total, 24.35.

Sandwich, DeKalb county: the precipitation of 1886, 27.41, is 13.20 below the average of the past thirty-five years; the precipitation of 1868, 1877, and 1878 is less than that of 1886, the fall for those years being respectively 26.75, 23.56, and 21.01.

*Indiana.*—Logansport, Cass county: since 1854 the greatest December precipitation, 5.99, fell in 1881; the least, 0.85, in 1886.

*Iowa.*—Monticello, Jones county: the precipitation of the year, 29.40, is 7.60 below the average of the past thirty-three years; in that time the largest December precipitation, 6.99, fell in 1856; the least, 0.65, in 1867.

*Kansas.*—Lawrence, Douglas county: the precipitation of the year, 24.25, is 11.02 below the average of the past nineteen years, it is also the smallest annual precipitation in that time.

*Massachusetts.*—Somerset, Bristol county: the precipitation of the year, 46.86, is 1.50 above the average of the past sixteen years.

*New York.*—Palermo, Oswego county: the precipitation of 1886, 31.10, is 5.80 below the average of the past thirty-three years; the total depth of snowfall, 75.75, is 20.00 below the average of the same time.

*Ohio.*—Wauseon, Fulton county: the total precipitation of the year, 30.38, is 8.33 less than the average of the past fourteen years, it is also the smallest in that time; the snowfall of the month, 19.90, is nearly double the average for December.

*Virginia.*—Dale Enterprise, Rockingham county: during the past six years the heaviest December precipitation, 5.04, fell in 1884; the least, 0.13, in 1882. The following table gives the total precipitation and depth of unmelted snow for each year from 1880 to 1886, inclusive:

Years.	Precipitation.	
	Rainfall and melted snow.	Snows, aggregate depth.
	Inches.	Inches.
1880.....	37.13	52
1881.....	38.61	20
1882.....	36.01	45
1883.....	37.42	35
1884.....	51.00	25
1885.....	47.37	22
1886.....	79.41	58
Mean.....	49.57	37

Wytheville, Wythe county: the total precipitation of the year, 46.44, is 4.65 above the average of the past twenty-two years.

Variety Mills, Nelson county: during the past eight years the greatest December precipitation, 6.29, fell in 1881; the least, 1.80, in 1880; the precipitation of the year, 48.73, is 9.43 above the average for seven years, it is also the greatest in that time; the least, 31.69, fell in 1879.

In the following table are shown, for the several geographical districts, the normal precipitation for December; the average for December, 1886, and the excess or deficiency as compared with the normal:

Average precipitation for December.

Districts.	Average for Dec., Signal-Service observations.		Comparison of Dec., 1886, with the average for several years.
	For several years.	For 1886.	
	Inches.	Inches.	Inches.
New England.....	4.41	5.31	+ 0.90
Middle Atlantic States.....	3.50	3.77	+ 0.27
South Atlantic States.....	4.33	3.90	- 0.35
Florida Peninsula.....	2.48	2.39	- 0.09
Eastern Gulf States.....	5.31	2.80	- 2.51
Western Gulf States.....	4.30	1.30	- 3.00
Rio Grande Valley.....	1.69	0.38	- 1.31
Tennessee.....	4.47	3.23	- 1.24
Ohio Valley.....	3.64	2.25	- 1.39
Lower lake region.....	3.04	2.88	- 0.16
Upper lake region.....	2.32	1.68	- 0.64
Extreme northwest.....	0.60	0.54	- 0.06
Upper Mississippi Valley.....	2.16	1.17	- 0.99
Missouri Valley.....	0.90	0.70	- 0.20
Northern slope.....	0.92	0.84	- 0.08
Middle slope.....	1.16	0.37	- 0.79
Southern slope.....	1.26	0.61	- 0.65
Southern plateau.....	1.36	0.16	- 1.20
Middle plateau.....	1.33	1.05	- 0.28
Northern plateau.....	2.27	3.39	+ 1.12
North Pacific coast region.....	8.22	10.73	+ 2.51
Middle Pacific coast region.....	3.95	3.39	- 0.56
South Pacific coast region.....	2.11	0.12	- 1.99

#### SNOW.

Montgomery, Alabama: on the 5th light snow began at 11.25 a. m.; at 1.30 p. m. it began falling heavily and continued until 5 a. m. of the 6th. This snow storm was heavier than any other that has occurred in this city; the depth in the vicinity of the Signal Office was eleven inches; reports from places outside of the city show a depth of from fifteen to eighteen inches. Railroad travel was interrupted and street cars were

blocked. The snow on the ground did not all disappear until the 11th.

Mobile, Alabama: light rain fell during the night of the 3d-4th and at intervals throughout the 5th. About noon the temperature began falling rapidly, the thermometer indicating 39° at 3 p. m. High northerly winds prevailed during the night of the 4-5th. Light snow began falling at 5.20 a. m. of the 5th and continued at intervals throughout the day; total snowfall one-half an inch; the storm was accompanied by high northwesterly wind and low temperature.

Livingston, Sumter county, Alabama: on the 4th and 5th snow fell to a depth of two inches and did not disappear until the afternoon of the 6th.

Pensacola, Florida: light rain fell during the afternoon of the 3d and until 5 a. m. of the 4th; shortly after midnight a heavy southeasterly wind set in, maximum velocity thirty-seven miles per hour. High wind and rain prevailed during the 5th, with low temperature and ice forming on calm water. Light snow fell from 4.25 to 8.20 p. m., average depth one and a half inches.

Forsyth, Monroe county, Georgia: on the 4th, 5th, and 6th, cold weather with sleet and snow prevailed; several years have passed since snow has fallen here so early in the season.

Charleston, South Carolina: the morning of the 6th opened with snow, which melted as it fell, and continued until 11 a. m. This is an unusual phenomenon for this region and was the first snow storm of any consequence that has occurred in Charleston for many years. The storm extended over the whole state; in some districts the snow did not melt but lay on the ground six or eight inches deep for several hours.

Columbia, South Carolina: during the 5th and 6th a very heavy sleet prevailed in this vicinity, and all objects were covered with ice from one to two inches in thickness. The city street railways were obliged to suspend travel on account of the ice. Reports from various parts of the surrounding country indicate that the storm was general, in some places heavy snow fell instead of sleet. It is stated that considerable apprehension was felt by farmers for the safety of their cattle, as in this state but few cattle are housed.

Asheville, Buncombe county, North Carolina: snow fell during the 5th and 6th to a depth of twenty-six inches. The weight of snow crushed the roof of the Asheville tobacco works, ruining a large stock of tobacco; the roofs of several other buildings were broken in by the snow.

Norfolk, Virginia: at 9.30 p. m. of the 6th light snow began falling, becoming heavy after midnight and continuing until 7.25 a. m. of the 7th. This was the heaviest snowfall that has occurred in this section of the country for several years and, being accompanied by high northerly winds, drifted to a considerable depth, causing a suspension of travel on the street-car lines.

Lynchburg, Virginia: snow began falling at 8.15 a. m. of the 4th and continued until the morning of the 5th, when it was accompanied by sleet and rain; during the night of the 5-6th heavy snow fell. The total depth of snowfall during this storm was thirteen inches. Trains on all roads passing through Lynchburg were delayed several hours. Reports show a very heavy snow in all parts of the state, especially in the mountainous portion. During this storm very low temperature prevailed, and the James River at this point was frozen from bank to bank and remained so until the 14th, when the ice broke up.

Wytheville, Wythe county, Virginia: snow began falling during the morning of the 4th and continued until the afternoon of the 6th; total depth sixteen inches. The roofs of several old buildings were crushed by the weight of snow. During the storm a number of sheep in the southern part of Fauquier county perished.

Petersburg, Virginia: snow fell on the 6th to the depth of fourteen inches. On the 7th street cars were obliged to suspend travel. Considerable damage was done to roofs by the weight of snow. The Appomattox River at this point was frozen over, impeding navigation for several days.



Chattanooga, Tennessee: snow began falling during the afternoon of the 3d and continued throughout the 4th and until the morning of the 5th. Heavy snow fell during the greater part of the 4th, with the temperature below freezing all day; total depth of snowfall thirteen inches. This storm was an unusual phenomenon for this section of the country; a similar snow storm has not occurred during the past thirty years. Street cars ceased running on the early morning of the 4th, and all trains arrived four to twelve hours late. Heavy snow fell also during the morning of the 6th.

Knoxville, Tennessee: the first snow of the season, and the heaviest that has occurred in this section for many years, began at 12.50 a. m. of the 4th and continued falling heavily until 10.30 p. m. At 12.10 a. m. of the 5th light snow began falling and continued at intervals throughout the day, the total depth for the two days was twenty-two and a half inches. All trains arriving on the 5th and 6th were several hours late, and many house roofs in the city were broken in by the weight of the snow.

Memphis, Tennessee: light snow fell at intervals during the 3d to a depth of five inches; snow fell also on the 4th and 5th. The street car tracks were obstructed by the heavy fall.

The dates on which snow fell in the various districts are as follows:

- New England.*—1st, 2d, 3d, 5th to 31st.  
*Middle Atlantic states.*—1st to 7th, 13th to 20th, 22d to 31st.  
*South Atlantic states.*—2d to 10th, 13th to 21st, 23d, 25th to 28th, 31st.  
*East Gulf states.*—3d to 6th.  
*West Gulf states.*—3d, 4th, 5th.  
*Tennessee.*—3d to 6th, 15th, 31st.  
*Ohio Valley.*—1st, 3d to 6th, 10th, 13th to 31st.  
*Lower lake region.*—1st to 7th, 11th, 13th to 31st.  
*Upper lake region.*—1st to 5th, 11th to 13th.  
*Extreme northwest.*—2d, 3d, 7th, 10th, 11th, 13th, 14th, 16th, 17th, 18th, 20th to 26th, 28th to 31st.  
*Upper Mississippi valley.*—1st, 3d, 4th, 10th to 31st.  
*Missouri Valley.*—2d, 3d, 4th, 11th, 12th, 14th, 16th, 17th, 18th, 20th, 21st, 23d to 31st.  
*Northern slope.*—1st to 5th, 10th, 11th, 13th to 18th, 20th to 31st.  
*Middle slope.*—2d, 3d, 4th, 10th, 11th, 12th, 15th to 23d, 25th, 26th, 27th, 29th, 30th, 31st.  
*Southern slope.*—4th, 30th, 31st.  
*Southern plateau.*—9th, 10th, 11th, 30th, 31st.  
*Middle plateau.*—8th to 13th, 16th, 17th, 20th to 26th, 28th to 31st.  
*Northern plateau.*—11th, 14th, 16th to 31st.  
*North Pacific coast region.*—6th, 9th, 10th, 11th, 20th, 21st, 22d, 25th to 29th.

#### MONTHLY SNOWFALLS.

[Expressed in inches and tenths.]

The following stations report monthly snowfalls of two inches or more:

- Alabama.*—Montgomery, 11; Livingston, 2.  
*Arizona.*—San Simon, 3.  
*Arkansas.*—Lead Hill, 2.6.  
*California.*—Summit, 34; Fort Bidwell, 15.5; Cisco, 11; Truckee, 8; Emigrant Gap, 6; Boca, 4.  
*Colorado.*—Denver, 10.8; Pike's Peak, 8.1; Montrose, 7.  
*Connecticut.*—North Colebrook, 38.5; Wallingford, 23.5; Hartford, 17.5; Uncasville, 16; New Haven, 13.3; Bethel, 12.8; New London, 10.  
*Dakota.*—Deadwood, 17.6; Fort Yates, 16.5; Fort Buford, 11.1; Webster, 8.4; Bismarck, 8.2; Yankton, 5.6; Huron, 4.9; Fort Totten, 4.3.  
*Delaware.*—Cape Henlopen, 4.  
*District of Columbia.*—Washington City, 16.6; Kendall Green, 6.5.  
*Georgia.*—Athens, 4.5.  
*Illinois.*—Windsor, 13.5; Sycamore, 13; Rockford, 10.8;

Pekin, 10.5; Chicago, 9.8; Sandwick, 9; Charleston, 7.6; Mattoon, 6.8; Anna, 6.2; Cairo, 6.1; Springfield, 5.

*Indiana.*—Logansport, 19.8; La Grange, 17.2; Angola, 16.2; Delphi and Farmland, 13.2; Columbia, 13; Fort Wayne, 12.5; Spiceland, 11.2; Marion, 10; Lafayette, 9.4; Mauzy, 9.2; Indianapolis, 9; Richmond, 8.4; Huntingburg, 5.7; Sunman, 5.6; Connersville, 5.4; Worthington, 4.9; Princeton, 4; Blue Lick, 3.8; Jeffersonville, 3.4; Franklin and Degonia, 2.5; Bloomington, 2.4.

*Iowa.*—Dubuque, 13.7; Keokuk, 12.2; Fort Madison, 9.5; Des Moines, 9.2; Independence, 8.4; Bancroft and Muscatine, 8; Cresco, 6; Monticello, 5.9; Davenport, 5.7; Cedar Rapids a, 3.5; Cedar Rapids b, 3 to 4.

*Kansas.*—Emporia, 5; Salina, 3.5; Globe and Concordia, 2.5; Lawrence, Wyandotte, and Wakefield, 2.

*Kentucky.*—Richmond, 10; Frankfort, 5.5; Louisville, 2.

*Maine.*—Orono, 38.5; Portland, 25.6; Gardiner, 24.2; Bar Harbor, 19; Eastport, 15.6.

*Maryland.*—Woodstock, 14.5; Fallston, 14; Baltimore, 10.2; Cumberland, 9.

*Massachusetts.*—Salem, 29.5; Blue Hill Observatory, 29; Taunton, 28.9; Wood's Holl, 27.7; Worcester, 24.4; Milton, 24; Westborough, 23.5; New Bedford and Williamstown, 21.5; Dudley, 21.1; Fall River, 21; Princeton and Somerset, 20; Boston, 18.5; Leominster, 17; Amherst and Mount Nonotuck, 16; Chicopee, 13; Vinyard Haven, 12.2; Holyoke, 11.1; North Truro, 10; Nantucket, 5.6.

*Michigan.*—Thornville, 28; Pentwater, 24; Traverse City, 23.5; Kalamazoo and Mottville, 22; Marquette, 21.1; Detroit, 20.8; Hudson, 20.5; Swartz Creek, 20.2; Alpena, 17.8; Grand Haven, 15.1; Lansing, 14.2; Port Huron and Birmingham, 13.2; Manistique, 9; Mackinaw City, 8.1; Escanaba, 6.4.

*Minnesota.*—Duluth, 9.3; Saint Paul, 7.4; Saint Vincent, 2.8.

*Montana.*—Helena, 20.2; Fort Assinaboine, 11.2; Poplar River, 10; Fort Custer, 9.1; Fort Maginnis, 3.5.

*Missouri.*—Saint Louis, 7.4; Centreville, 4.1; Central College, 2.2.

*Nebraska.*—Fremont, 16.3; North Platte, 14.2; Genoa, 9.7; Valentine, 8.4; Hay Springs, 7.7; Marquette, 7.4; Crete, 5.3; Tecumseh, 5; Stockham, 4.2; Brownville, 4.

*Nevada.*—Otego, 4.2; Toano, 3.8; Palisade, 3; Tacoma, 2.2; Halleck, 2.

*New Hampshire.*—Mount Washington, 38.1; Nashua, 26.8; Antrim, 25; Berlin Mills, 22.

*New Jersey.*—Dover, 20.7; South Orange, 16; Moorestown, 15; Roseland, 14.5; Beverly, 13.8; Paterson, 13.5; Clayton, 8.5; Atlantic City, 8; Upper Montclair, 2.

*New Mexico.*—Santa Fé, 4.3.

*New York.*—Oswego, 29.4; Buffalo, 24.9; New York City, 21.9; White Plains, 21; Palermo, 19.5; Humphrey, 17.5; Auburn, 14.5; Setauket and Cooperstown, 13; Rochester, 12.5; Ithaca, 12.2; Albany, 11.1; Menand's, 11; Le Roy, 10.9; Penn Yan, 8.5; Factoryville, 7.9.

*North Carolina.*—Flat Rock, 20; Weldon, 9.5; Chapel Hill, 9; Statesville, 6; Lincolnton, 5.5.

*Ohio.*—Cleveland, 20; Wauseon, 19.9; Sandusky, 19.3; Hiram and Tiffin a, 18; Toledo, 17.8; Garrettsville, 16.5; Napoleon, 16.4; Tiffin b, 15; North Lewisburg, 13.8; West Milton, 10; Columbus, 9.9; College Hill and Jacksonborough, 7; Westerville, 4.3; Portsmouth, 3.6; Yellow Springs, 3.1.

*Oregon.*—Lakeview, 7.8.

*Pennsylvania.*—Erie, 24; Dyberry, 18.5; West Chester and Phillipsburg, 18; Bethlehem, 17; Easton, 16.7; Grampian Hills, 16; Catawissa, 13.3; Wellsborough, 13.2; Drifton, 11.2; Fallsington, 10.5; Zionsville, 10.1; Quakertown, 10; Philadelphia, 9.6; Wilkesbarre, 9.5; Blooming Grove, 9.4; Wysox, 6; Pittsburg, 4.4.

*Rhode Island.*—Lonsdale, 20.7; Pawtucket, 19.4; Narragansett Pier, 12.5; Block Island, 12.

*South Carolina.*—Spartanburg, 8.6; Pacolet, 5.5.

*Tennessee.*—Greeneville and Jonesborough, 36; Rogersville,

27; Parksville, 26; Knoxville, 25.4; Grief, 24.5; Postoria, 20; Howell, 17.5; Manchester and Andersonville, 15.5; Farmingdale, 15; Chattanooga, 14.8; Beech Grove, 14.5; Cookeville, 13; Savannah, 12; Careyville, 11.5; Ashwood and Hurricane Switch, 11; Bolivar and Waynesborough, 10; Riddleton, 8.2; Hohenwald, 8; Florence Station, 7.6; Memphis, 6.7; Milan, Austin, and Sailor's Rest, 6; Covington, 5.5; Dickson, 4.3; Nashville, 4.2; McKenzie, 4; Waverly, 3.8; Trenton, 3.2.

*Utah.*—Salt Lake City, 5.6.

*Vermont.*—Strafford and Lunenburg, 20; Newport, 22.2; Post Mills, 21; Poultney, 18.3; Burlington, 17.

*Virginia.*—Marion, 39; Wytheville, 27; Rappahannock, 22.8; Dale Enterprise, 17; Lynchburg, 13.3; Accotink, 12; University of Virginia, 11.8; Variety Mills, 11.2; Norfolk, 9.2; Chincoteague, 4.1; Cape Henry, 4.

*Washington Territory.*—Fort Spokane, 14.5; Walla Walla, 8.7; Bainbridge Island and Pysht, 6; Tacoma, 2.5.

*West Virginia.*—Middlebrook, 36; Helvetia, 27; Port Angeles, 6.1; Parkersburg, 3.

*Wisconsin.*—Milwaukee, 19; Fond du Lac, 16.5; Manitowoc, 12.2; Delavan, 11.2; Green Bay, 9.2; Madison and Prairie du Chien, 9; Embarras, 7.1; Wausau, 4.5; La Crosse, 4.1.

*Wyoming.*—Fort Laramie, 7.5; Fort Bridger, 5.7.

#### DEPTH OF UNMELTED SNOW ON GROUND AT END OF MONTH.

[Expressed in inches and tenths.]

*Colorado.*—Denver, 3; Pike's Peak, 2.5; Montrose, 2.

*Connecticut.*—North Colebrook, 9; Hartford, 3; Bethel, 2; New London, 1; New Haven, 0.5.

*Dakota.*—Richardton, 12; Webster and Deadwood, 8; Bismarck, 7.7; Fort Totten, 7; Yankton, 4.7; Huron, 4.

*District of Columbia.*—Kendall Green, 0.4; Washington City, trace.

*Idaho.*—Boisé City, 0.3.

*Illinois.*—Pekin, 9; Charleston, 7.5; Peoria, 7; Sycamore, 6; Sandwich, 5; Collinsville and Windsor, 4.5; Mattoon, 4; Springfield, 2; Cairo, 0.1.

*Indiana.*—Logansport, 12.6; Mauzy, 9.2; Indianapolis, 3.8; Sunman, 0.5; Jeffersonville and Butler, trace.

*Iowa.*—Bancroft, 10; Keokuk, 8.3; Dubuque, 7.5; Fort Madison and Independence, 7; Cresco, 5; Monticello, 4; Davenport, 3; Cedar Rapids, 2.5; Des Moines, 2.

*Kansas.*—Globe, 0.5; Wyandotte, 0.3.

*Kentucky.*—Richmond, 0.5; Frankfort, 0.3; Louisville, trace.

*Maine.*—Orono, 15; Gardiner, 7; Portland, 3; Bar Harbor, 1; Eastport, 0.5.

*Maryland.*—Cumberland, 3; Woodstock, 2; New Midway and Baltimore, 1.

*Massachusetts.*—Princeton, 12; Amherst a, 6; Amherst b, Worcester, and Williamstown, 5; Somerset and Blue Hill Observatory, 4; Dudley, Fall River, Taunton, Boston, and Milton, 3.

*Michigan.*—Thornville, 20; Swartz Creek and Manistique, 18; Hudson, Kalamazoo, Pentwater, and Traverse City, 12; Lansing and Grand Haven, 11; Port Huron, 10; Marquette, 8; Detroit, 6; Alpena, 4; Mackinaw City and Escanaba, 3.

*Minnesota.*—Duluth, 12; Saint Paul, 10; Saint Vincent, 2.

*Montana.*—Helena, 12; Poplar River and Fort Assinaboine, 10.8; Fort Custer, 8.

*Missouri.*—Saint Louis, 6; Central College and Conception, 1; Centreville, 0.4.

*Nebraska.*—Genoa and Hay Springs, 6; Crete, 5.3; Fremont and Tecumseh, 5; Marquette and Valentine, 3; Brownville, 2; Stockham, 1.5; North Platte, 0.5.

*New Hampshire.*—Mount Washington, 22; Nashua, 10.

*New Jersey.*—South Orange, 3; Dover, 2; Beverly and Moorestown, 1; Upper Montclair, 0.5; Paterson, 0.2; Clayton, trace.

*New York.*—North Volney, 12 (in the woods); Oswego, 9; Palermo, 8; Le Roy, 6 to 8; Cooperstown, Factoryville, and Ithaca, 6; Humphrey and Buffalo, 5; Menand's, Penn Yan,

and Albany, 4; Auburn and White Plains, 3; Brooklyn, 2; Rochester, 1.7; New York City, 1.

*Ohio.*—Wauseon, 16; Sandusky, 12; Elyria and Tiffin a, 9.5; Napoleon, Tiffin b, Toledo, and Cleveland, 8; Hiram, 6; Garrettsville, 5; North Lewisburg, 4; West Milton, 3; Jacksonborough, 2; College Hill, Columbus, and Westerville, 1; Yellow Springs, 0.5.

*Pennsylvania.*—Easton, 16.7; Dyberry, 10; Grampian Hills, 9; Wysox, 8; Wellsborough, 5.6; Erie, 4; Catawissa and Phillipsburg, 3; Drifton, Wilkesbarre, and Zionsville, 2; Fallington and West Chester, 1.5; Pittsburg and Philadelphia, 0.5; Quakertown, trace.

*Rhode Island.*—Block Island, trace.

*Vermont.*—Newport, 20; Strafford, 18; Post Mills and Poultney, 13; Charlotte, 10 to 12; Burlington, 3.

*Virginia.*—Rappahannock, 3; Accotink and University of Virginia, 1; Dale Enterprise, Marion, and Variety Mills, trace.

*Washington Territory.*—Fort Spokane, 6; Walla Walla, 4.

*West Virginia.*—Middlebrook, 16; Helvetia, 1.

*Wisconsin.*—Milwaukee, 11; Fond du Lac, 9; Delavan, 8; Embarras and Green Bay, 7; Madison, 6; Prairie du Chien, 5; Wausau and La Crosse, 4.

#### HAIL.

Portland, Maine: on the 1st, between 1 and 2 a. m., a heavy thunder-storm, moving from the southeast to the northwest, passed over the city. The electrical part of the storm was quite severe for this season of the year, and one person was killed by lightning. Hail, the size of robin's eggs, fell from 1.25 to 1.30 a. m.

Hail is also reported to have occurred, as follows:

*Arizona.*—Prescott, 10th.

*California.*—Keeler, 9th.

*Colorado.*—Colorado Springs, 18th.

*Indian Territory.*—Fort Gibson, 3d.

*Kansas.*—Salina, 11th; Yates Centre, 12th; Dodge City, 14th.

*Louisiana.*—Liberty Hill, 17th; Shreveport, 23d.

*Maryland.*—Emmitsburg, 29th.

*Massachusetts.*—Amherst and Dudley, 31st.

*Michigan.*—Kalamazoo, 13th.

*New Jersey.*—Moorestown, 6th, 7th, 21st; Beverly, 6th, 26th, 31st; Dover and Upper Montclair, 31st.

*New York.*—Setauket, 5th, 7th, 31st.

*North Carolina.*—Raleigh, 5th; Weldon, 5th, 6th.

*Ohio.*—Jacksonborough, 14th, 17th; Garrettsville, 31st.

*Pennsylvania.*—Bethlehem, Quakertown, and Zionsville, 31st.

*Tennessee.*—Chattanooga, 4th.

*Virginia.*—Chincoteague, 5th; Dale Enterprise, 18th, 30th, 31st; Bird's Nest, 29th.

#### SLEET.

Sleet fell in the various states and territories during the month, as follows:

*Arkansas.*—Little Rock, 3d, 4th, 28th, 29th.

*Connecticut.*—New London, 5th, 7th; New Haven, 7th; Bethel, 31st.

*Dakota.*—Fort Totten, 10th, 13th; Yankton, 12th.

*Georgia.*—Augusta, 3d, 4th, 5th; Atlanta, 4th; Milledgeville, 4th, 5th.

*Illinois.*—Springfield, 23d; Cairo, 28th.

*Indiana.*—Indianapolis, Butler, Mauzy, Sunman, and Vevay, 31st.

*Iowa.*—Keokuk, 23d.

*Kansas.*—Concordia, 12th; El Dorado, 30th; Leavenworth, 30th, 31st.

*Kentucky.*—Louisville, 17th, 30th, 31st; Frankfort, 29th, 30th.

*Maine.*—Eastport, 16th.

*Maryland.*—Emmitsburg, 29th.

*Massachusetts.*—Vineyard Haven, 5th; Worcester, 12th.

*Michigan.*—Grand Haven, 13th.

*Nebraska.*—Genoa, 16th.



**Nevada.**—Winnemucca, 29th.  
**New Hampshire.**—Mount Washington, 25th.  
**New York.**—Albany, 1st, 8th, 31st; Setauket, 7th, 31st;  
 New York City, 15th, 31st; Palmyra, 31st.  
**North Carolina.**—Wilmington and Charlotte, 4th; Weldon,  
 31st.  
**Ohio.**—North Lewisburg, 1st; Cleveland, 13th, 14th, 31st;  
 Cincinnati, 17th; Portsmouth, 17th, 31st; Columbus, West  
 Milton, and Yellow Springs, 31st.  
**Pennsylvania.**—Philadelphia, 6th; Franklin, 30th, 31st;  
 Zionsville, 31st.  
**Rhode Island.**—Block Island, 7th.  
**Tennessee.**—Nashville and Milan, 28th.  
**Virginia.**—Accotink, 5th; Variety Mills, 5th, 6th, 29th, 30th;  
 Lynchburg, 5th, 29th, 30th, 31st; Norfolk and Cape Henry,  
 6th; Chincoteague, 6th, 29th, 30th.  
**Washington Territory.**—Walla Walla, 19th, 27th to 31st;  
 Port Angeles, 25th; Pysht, 26th.

Table of excessive and greatest monthly precipitation for December, 1886.

Station.	Specially heavy.		Largest monthly.	Station.	Specially heavy.		Largest monthly.
	Date.	Amt.			Date.	Amt.	
British Columbia.				Oregon—Con.			
New Westminster.			15.89	Mount Angel.	8	2.10	12.45
California.				Bandon.	8	2.05	11.97
Fort Gaston.	10, 11	3.12	15.81	Do.	27, 28	2.42	
Do.	27, 28	3.70		Portland.	25, 26	2.20	11.52
Delta.			8.81	East Portland.			11.34
Emigrant Gap.			7.40	Albany.			10.31
Colfax.			6.12	Eola.			9.08
Connecticut.				Roseburg.			7.30
Voluntown.			6.15	Fort Klamath.			6.55
Florida.				Rhode Island.			
Pensacola.	10, 11	2.37		Block Island.			6.70
Sanford.	10, 11	2.18		Tennessee.			
Alva.	31	2.00		Greenville.	5	3.00	
Illinois.				Jonesborough.	5	3.00	
Marengo.	23	2.00		Parksville.	6	2.00	
Anna.	23, 24	2.03		Washington Ter.			
Louisiana.				Neah Bay.	2, 3	3.65	30.70
Grand Coteau.	25	2.12		Do.	12	3.10	
Maine.				Do.	15, 16, 17	0.05	
Eastport.	25	2.17	6.51	Do.	27, 28	3.60	
Orono.			6.38	Do.	30, 31	2.05	
Massachusetts.				Tatoosh Island.	12, 13	4.02	25.84
New Bedford.			6.92	Do.	15, 16	2.56	
North Carolina.				Do.	27, 28	3.17	
Charlotte.	5	2.06	6.26	Do.	31	2.38	
Flat Rock.	4, 5, 6	3.95		Fort Canby.	6, 7	2.79	17.35
Hatteras.	5	2.65		Do.	31	2.58	
Oregon.				Olympia.	31	2.50	13.38
Astoria.	2, 3	2.02	16.89	Bainbridge Isl'd.			11.15
Do.	26, 27	2.12		Tacoma.	31	2.82	11.09
Gardiner.	8	2.65	13.97	Walla Walla.			7.86
Do.	28, 29	3.64		Port Angeles.			7.71

## WINDS.

The most frequent directions of the wind during December, 1886, are shown on chart ii by the arrows flying with the wind; they are also given in the table of miscellaneous meteorological data. In the Missouri and upper Mississippi valleys, Dakota, and Minnesota, the wind blew mostly from the north or northwest; in the Lake regions the prevailing direction was west; in New England and the middle Atlantic states, northwest. In other portions of the country the winds were variable.

## HIGH WINDS.

[In miles per hour.]

Wind-velocities of fifty or more miles per hour were recorded during the month, as follows:

Mount Washington, New Hampshire, 84, nw., 1st; 84, nw., 2d; 83, w., 3d; 89, w., 4th; 54, se., 7th; 78, nw., 8th; 76, nw., 9th; 99, nw., 10th; 98, nw., 11th; 54, s., 13th; 84, w., 14th; 71, sw., 15th; 92, nw., 16th; 94, nw., 17th; 50, sw., 18th; 70, w., 19th; 78, w., 21st; 56, sw., 23d; 64, sw., 24th; 100, nw., 25th; 87, w., 27th; 77, nw., 28th; 78, w., 29th.

Pike's Peak, Colorado, 54, w. and nw., 1st; 52, nw., 2d; 58, n., 3d; 66, w., 9th; 74, n., 14th; 58, nw., 15th; 72, nw., 16th; 76, w., 20th; 72, nw., 22d; 70, n., 23d; 76, w., 24th; 50, w., 25th; 80, w., 26th; 72, nw., 27th; 56, nw., 28th; 64, w., 29th; 58, w., 30th; 56, n., 31st.

Cape Mendocino, California, 50, se., 5th; 76, se., 6th; 72, se., 7th; 60, se., 8th; 64, se., 10th; 72, se., 11th; 52, se., 12th; 65, se., 27th; 88, s., 28th; 70, se., 29th; 56, se., 30th; 52, se., 31st.

Fort Canby, Washington Territory, 50, se., 7th; 50, s., 12th; 50, s., 13th; 50, se., 15th; 58, s., 28th.

Block Island, Rhode Island, 51, ne., 6th.

Chincoteague, Virginia, 52, nw., 6th.

Nantucket, Massachusetts, 50, ne., 7th.

Tatoosh Island, Washington Territory, 51, se., 12th.

Fort Assinaboine, Montana, 52, s., 13th.

Fort Maginnis, Montana, 52, w., 13th; 54, w., 19th.

Valentine, Nebraska, 56, nw., 14th.

Fort Elliott, Texas, 52, nw., 14th.

Sandusky, Ohio, 52, n., 15th.

Fort Totten, Dakota, 50, sw., 20th.

Fort Buford, Dakota, 50, w., 20th.

Kitty Hawk, North Carolina, 52 ne., 25th.

## INLAND NAVIGATION.

## STATE OF WATER IN RIVERS AND HARBORS.

Heavy ice formed on the Mississippi River in the vicinity of Cairo, Illinois, on the 1st. Owing to the low stage of water in the river, and its consequent liability to freeze quickly, the Anchor line of steamers went into winter quarters as they arrived at this port. On the 4th the river had become covered with heavy ice from the mouth of the Ohio to Saint Louis. At Bird Point, Missouri, the junction of the Mississippi and Ohio Rivers, the ice had been forced up to such a height around the "cradles" that the transfer steamers were unable to reach their wharves. Owing to the low stage of water in the river several steamers were aground a short distance above Cairo on the same date; on the 14th the river was reported by steamboat men to be lower than at any other time during the past five years, and many old wrecks were visible that had not been seen since their destruction. Heavy floating ice passed down the Ohio and Mississippi Rivers at Cairo every day of the month; on the 30th it became heavy enough to impede navigation. At Saint Louis, Missouri, river navigation was suspended on the 1st on account of low water and floating ice; during the afternoon of the same day the Mississippi River was gorged with ice at Warsaw, Illinois, and the Illinois River at Beardstown, Illinois. The observer at Saint Louis, Missouri, states that the Mississippi River was lower during the first five days of the month than at any other time since river observations have been made; after the 6th it began rising and on the 19th was 7.9 feet above low-water mark. On the 6th the ice gorged at South Saint Louis, causing a rise of five feet at points immediately above; the gorge did not break until 4 p. m. of the 10th, and resulted in a rapid decline in the river at this point. Large quantities of ice passed down the river every day of the month. At Dubuque, Iowa, very low temperatures prevailed during the 1st, 2d, and 3d, and ice began forming rapidly on the Mississippi River at Dubuque, on the 1st; on the 3d the river was covered with ice of such thickness as to allow vehicles to cross from one side to the other.

Navigation on the Hudson River became practically closed for the season about the 6th; on that date the ice in the river, from Rondout northward, ranged from two to six inches in thickness and ice men were already at work filling their ice-houses. All the freight and passenger steamers plying between New York City and points north of Poughkeepsie went into winter quarters about the 4th. The propeller "Newburg" left New York City on the 27th for Newburg, but became fast in the ice when two miles north of Cold Spring, New York, and was obliged to return.

Duluth, Minnesota: the water in the harbor became frozen over on the 5th and ice began forming along the lake shore on the same date. A field of ice was observed on the 16th near the south shore; it continued to extend until the 24th, when it was within a mile of the north shore, and at the end of the month had nearly covered the lake.

Escanaba, Michigan: the steam tug "Swain," having in tow the schooner "Swallow," left port on the morning of the 6th for Detroit. This was the last vessel to leave port this season and navigation was practically closed on that date.

Milwaukee, Wisconsin: there was more ice in Milwaukee Bay at the end of the month than there has been in any December during the past ten years; on the 31st three propellers were fast in the ice for several hours.

Erie, Pennsylvania: the propeller "Philadelphia," of the Anchor Line, reached this port, by forcing her way through the ice, on the morning of the 7th; this was the last vessel to arrive at this port, and navigation was closed for the season.

Sandusky, Ohio: Sandusky Bay became frozen over on the 1st and navigation was closed for the season. All steamers at this port have gone into winter quarters.

Little Rock, Arkansas: the steamer "Ella" arrived on the 18th, but, owing to the low stage of the water in the Arkansas River, was unable to depart. On the 27th the river was navigable for small boats only.

Louisville, Kentucky: on the 22d and 23d the Ohio River was filled with heavy floating ice which impeded the progress of steamboats.

Leavenworth, Kansas: the Missouri River at this point was frozen over from the 4th to 10th and from the 27th to 31st; on all other days of the month it was filled with heavy floating ice.

Rochester, New York: the Genesee River became frozen on the 2d, closing navigation for the season.

Philadelphia, Pennsylvania: ice formed rapidly on the Delaware and Schuylkill rivers during the 5th, making navigation difficult. Navigation on the Schuylkill River closed this season unusually early and a large number of canal boats were ice bound.

In the following table are shown the danger-points at the various river stations; the highest and lowest depths for December, 1886, with the dates of occurrence, and the monthly ranges:

Heights of rivers above low-water mark, December, 1886.  
[Expressed in feet and tenths.]

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Date.	Height.	Date.	Height.	
<i>Red River:</i>						
Shreveport, Louisiana.....	29.9	1 to 5	10.5	28 to 31	4.0	6.5
<i>Arkansas River:</i>						
Fort Smith, Arkansas.....	22.0	24 to 27	1.6	7, 8	0.8	0.8
Little Rock, Arkansas.....	23.0	1	3.3	21, 22, 23	1.3	2.0
<i>Missouri River:</i>						
Yankton, Dakota.....	24.0					
Omaha, Nebraska.....	18.0					
Leavenworth, Kansas.....	20.0	12	6.0	18	3.1	2.9
<i>Mississippi River:</i>						
Saint Paul, Minnesota.....	14.5					
La Crosse, Wisconsin.....	24.0					
Dubuque, Iowa.....	16.0	5	3.2	1	1.7	1.5
Davenport, Iowa.....	15.3					
Keokuk, Iowa.....	14.0					
Saint Louis, Missouri.....	32.0	19	7.9	7, 4, 5	7.0	7.8
Cairo, Illinois.....	40.0	1	23.8	17, 18	9.2	14.6
Memphis, Tennessee.....	34.0	3	16.4	20	6.6	11.8
Vicksburg, Mississippi.....	41.0	8, 9	20.5	25	6.3	14.3
New Orleans, Louisiana.....	13.0	9	5.1	26, 28	3.0	3.1
<i>Ohio River:</i>						
Pittsburg, Pennsylvania.....	22.0	26	12.3	11, 12	3.8	9.5
Cincinnati, Ohio.....	50.0	20	27.2	14, 15	10.0	17.3
Louisville, Kentucky.....	25.0	1	11.4	15	5.6	5.8
<i>Cumberland River:</i>						
Nashville, Tennessee.....	40.0	23	20.8	12, 13	4.7	16.1
<i>Tennessee River:</i>						
Knoxville, Tennessee.....	14	8	8	2, 3	5.7	
Chattanooga, Tennessee.....	33.0	22	16.6	12	4.0	12.6
<i>Monongahela River:</i>						
Pittsburg, Pennsylvania.....	29.0	26	12.3	11, 12	2.8	9.5
<i>Savannah River:</i>						
Augusta, Georgia.....	32.0	13	11.5	4, 5	6.5	5.0
<i>Moblie River:</i>						
Mobile, Alabama.....		4	16.8	16	15.1	1.7
<i>Sacramento River:</i>						
Sacramento, California.....		10, 11	10.9	1 to 7	7.8	3.1
<i>Willamette River:</i>						
Portland, Oregon.....		26, 29, 30	10.0	6	0.1	9.9
<i>Colorado River:</i>						
Yuma, Arizona.....		16 to 23, 25, 26, 27	13.6	3, 4, 5	14.9	0.7

\* River frozen. † Approximated.

## ATMOSPHERIC ELECTRICITY.

### AURORAS.

Mount Washington, New Hampshire: a faint auroral light was observed from 9.50 to 11.30 p. m. of the 17th; it was accompanied by no streamers or other distinctive features.

Fort Buford, Dakota: an auroral light of a pale white color appeared on the northern horizon at 9.28 p. m. of the 22d; it extended from northwest to northeast and to an altitude of about 15°. Between 10.15 and 10.25 p. m. a few white streamers, extending to an altitude of 27°, were visible in the north. The aurora was obscured by clouds at 11.45 p. m.

Saint Vincent, Minnesota: an aurora was observed in the north at 11 p. m. of the 25th; it first appeared in the form of a low line of light extending from north to northeast, and having an altitude of about three degrees. At 11.15 p. m. the light had become wider and white beams shot upward from different parts of the base. At the base the colors increased in intensity, showing successively white, lemon, orange, and red, the last-named color was the last to disappear, remaining visible until the early morning of the 26th.

Bismarek, Dakota: an auroral arch extending from azimuth 150° to 225° and to an altitude of 30° was seen at 12.45 a. m. of the 26th. The maximum intensity occurred at 1.15 a. m. when beams of bright light extended to an altitude of 40°. The display ended at 7.45 a. m.

Marquette, Michigan: an aurora was visible from 9.15 to 10.20 p. m. of the 29th; several streamers extended to a height of 40°.

Other auroral displays were observed during the month, as follows:

- 1st.—Escanaba, Michigan; Green Bay, Wisconsin; Gardiner, Maine.
- 2d.—Escanaba, Michigan; Embarras, Wisconsin.
- 4th.—Nashua, New Hampshire.
- 7th.—Moorhead, Minnesota.
- 12th.—Wellsborough, Pennsylvania.
- 15th.—Sandwich, Illinois.
- 17th.—Gardiner, Maine.
- 20th.—Eastport, Maine.
- 22d.—Bismarek and Fort Totten, Dakota; North Volney, New York.
- 23d.—Bismarek, Dakota.
- 25th.—Fort Totten, Dakota; Helena, Montana.
- 26th.—Poplar River, Montana.
- 28th.—Mackinaw City and Escanaba, Michigan; Nashua, New Hampshire; Embarras, Wisconsin.
- 29th.—Mackinaw City and Escanaba, Michigan.
- 31st.—Delavan, Wisconsin.

### ELECTROMETER READINGS.

[Prepared under the direction of Prof. T. C. Mendenhall, Assistant.]

Observations have been made regularly at 9 a. m., 11 a. m., 1 p. m., and 3 p. m., daily, at the six stations now supplied with electrometers. At Washington City, owing to severity of the weather, observations at the top of the Washington Monument were only made with difficulty. On December 15th, during cold, rainy weather, values were obtained as follows:

Time.	Monument.	Signal Office.	Time.	Monument.	Signal Office.
	Volts.	Volts.		Volts.	Volts.
9 a. m.		+ 90	12.05 p. m.	125	- 72
11 a. m.		- 270	12.10 p. m.	225	- 36
		- 350	12.15 p. m.	225	+ 6
11.15 a. m.	500		12.20 p. m.	500	+ 132
11.30 a. m.	1375		12.25 p. m.	450	+ 48
11.45 a. m.	400		12.30 p. m.	125	+ 36
12 m.		- 225	12.35 p. m.	125	+ 30

Monument elevation, 500 feet.

Signal Office elevation, 35 feet.

Sparks could be obtained at the Monument by connecting



*Table of miscellaneous meteorological data for December, 1886—Signal Service observations.*

[illegible]





*Meteorological record of voluntary observers and Army post surgeons, December, 1886.*

The maximum and minimum temperatures at stations marked thus (\*) are from readings of other than standard instruments.

Stations.	Temperature.				Stations.	Temperature.			
	Maximum.	Minimum.	Mean.	Rainfall.		Maximum.	Minimum.	Mean.	Rainfall.
<i>Alabama.</i>	°	°	°	Inches	<i>Iowa.</i>	°	°	°	Inches
Greensborough.....	70	32	45.8	2.11	Bancroft.....	42	-24	10.3	1.32
Livingston.....	71	20	45.8	2.48	Cedar Rapids a.....	50	-20	16.5	
Mount Vernon B'ks.....	71	20	49.3	1.42	Cedar Rapids b.....	33	-28	13.3	
<i>Arizona.</i>					Cresco.....	43	-32	9.1	0.80
Apache, Fort.....	80	26	53.0	0.10	Des Moines.....	54	-28	16.9	
<i>Arkansas.</i>					Independence.....	46	-26	13.6	0.84
Lead Hill.....	67	0	32.5	1.51	Monticello.....	53	-29	14.2	0.84
<i>British Columbia.</i>					Mount Vernon.....	51	-27	14.2	
New Westminster.....				15.89	Muscataine.....	48	-26	10.6	0.71
<i>California.</i>					<i>Kansas.</i>				
Alcatraz Island.....	62	44	51.9	1.85	Allison.....	68	-2	26.3	trace
Angel Island.....	71	42	53.2	2.00	Blue Rapids.....	59	-7	26.0	0.88
Buena Barracks.....	62	38	51.6	1.42	Elk Falls.....				0.20
Bidwell, Fort.....	55	20	39.9	3.92	El Dorado.....	59	-4	27.8	0.19
Fall Brooke.....	54	38	53.9	0.30	Emporia.....	59	-9	26.1	0.80
Gaston, Fort.....	61	32	48.8	15.81	Globe.....	59	-12	22.4	0.80
Mason, Fort.....	63	44	53.6	1.36	Hays, Fort.....	66	-9	27.4	0.68
Nicolaus.....	74	31	50.0	1.99	Lawrence.....	58	-6	24.0	0.83
Oakland.....	63	30	52.0	3.60	Manhattan a.....	60	-7	23.5	1.39
Oroville.....	70	37	52.2	2.75	Manhattan b.....	62	-5	24.3	1.58
Presidio of San F.....	68	39	52.4	1.18	Ninnescah.....	62	-5	27.2	0.23
Princeton.....	72	27	49.3	1.57	Riley, Fort.....	59	-8	24.3	0.62
Sacramento.....	63	26	47.3	2.13	Salina.....	52	-2	29.4	1.05
Salinas.....	77	32	49.8	0.72	West Leavenworth.....	59	-5		2.10
Santa Barbara.....	82	40	55.8	0.86	Wyandotte.....	59	-7	24.4	1.18
Suevian.....	54	20	38.0	2.23	Wellington.....	62	-4	28.3	0.68
<i>Colorado.</i>					Wheatfield.....	58	-4	26.0	1.20
Colorado Springs.....	61	0	33.5	0.16	Yates Centre.....	60	-11	25.5	0.49
Lewis, Fort.....	58	5	30.1	0.26	<i>Kentucky.</i>				
<i>Connecticut.</i>					Frankfort.....	64	-1	28.9	3.52
Bethel.....				3.30	Richmond.....	59	-4	30.4	3.89
Hartford.....	44	-2	22.8	4.31	<i>Louisiana.</i>				
North Colebrook.....	47	-2	21.4	1.35	Grand Coteau.....	72	-22	52.2	3.26
Voluntown.....	54	-1		6.15	Liberty Hill.....				2.11
<i>Dakota.</i>					<i>Maine.</i>				
Abr. Lincoln, Fort.....	43	-34	2.5	1.20	Bar Harbor.....	52	-10		
Henry.....	39	-22	8.1	0.25	Cornish.....	46	-7	20.0	1.96
Meade, Fort.....	53	-24	20.5	0.72	Gardiner.....	52	-10	23.3	4.08
Pembina, Fort.....	33	-35	-0.7	1.70	Orono.....	47	-15	18.1	0.38
Richardson.....	38	-35	7.2	0.90	<i>Maryland.</i>				
Sisseton, Fort.....	40	-37	4.1	0.33	Cumberland.....	44	-8	29.1	1.77
Sully, Fort.....	51	-33	9.9	0.74	Emmitsburg.....	40	-9	28.0	2.89
Totten, Fort.....	39	-34	1.0	0.49	Fallston.....	51	-11	28.6	4.22
Webster.....	44	-37	1.4	2.32	Great Falls.....	50	-10	29.6	3.07
Yates, Fort.....	40	-44	5.8	1.60	McDonough.....	51	-10	29.4	2.39
<i>District of Columbia.</i>					McHenry, Fort.....	53	-14	31.3	1.29
Distributing reservoir.....	46	13	30.8	2.77	New Midway.....	50	-12	32.1	1.93
Kendall Green.....	50	14	36.8	2.45	Woodstock.....	50	-6	29.0	2.11
Receiving reservoir.....	46	10	29.9	2.54	<i>Massachusetts.</i>				
Rock Creek.....	50	14	33.9		Amherst a.....	49	-1	23.0	3.61
<i>Florida.</i>					Amherst b.....	48	-3	25.6	3.12
Archer.....	78	24	56.0	3.32	Blue Hill Obs'y.....	51	-3	25.1	5.54
Alva.....	83	34	52.2	4.45	Doerfield.....	50	-9	23.5	2.94
Duke.....	80	29	53.3	2.46	Dudley.....	50	-1	22.1	4.06
Meade, Fort.....				2.30	Fall River.....	48	-8	28.4	5.25
Manatee.....	84	38	59.5	1.78	Milton.....	52	-9	28.9	1.16
Lincoln.....	82	32	62.0	1.90	New Bedford.....	52	-7	29.9	0.92
Tallahassee.....	72	25	51.0	4.85	North Truro.....				2.58
<i>Georgia.</i>					Princeton.....	48	-2	21.9	4.21
Athens.....	57	16	39.1	4.39	Somerset.....	57	-6	28.4	5.54
Forrest.....	65	33	49.1	3.18	Taunton.....	54	-5	27.7	3.74
Milledgeville.....	65	19	43.4	3.25	Westborough.....	46	-4	28.3	4.06
Quitman.....	73	26		2.65	Williamstown.....	49	-0	22.1	4.04
<i>Idaho.</i>					Worcester.....	47	-4	24.6	4.24
Boise Barracks.....	61	21	37.8	2.28	<i>Michigan.</i>				
Coeur d'Alene, Fort.....	58	9	34.1	5.38	Birmingham.....	43	-9		2.03
<i>Illinois.</i>					Harrisville.....	59	-10		2.65
Anna.....	56	-6	30.4	3.25	Hudson.....	49	-13		2.02
Bloomington.....	64	-16			Kalamazoo.....	48	-2	25.0	2.02
Collinsville.....	53	-4	24.6	1.88	Lansing.....	50	-10	19.6	1.22
Charleston.....	53	-9	22.6	1.92	Manistique.....	42	-24	6.8	1.37
Geneseo.....	55	-25	13.5	0.84	Mottville.....	52	-8		1.63
Mattoon.....	54	-8	24.7	1.88	Pontwater.....	48	-3		2.94
Pekin.....	54	-19	19.4	1.18	Swarts Creek.....	47	-14	17.8	1.95
Peoria.....	50	-13	23.0	0.89	Thornville.....	47	-12	19.6	3.12
Riley.....	50	-23	15.4	1.13	Traverse City.....	46	-7		3.16
Rockford.....	49	-18	18.2	1.65	<i>Minnesota.</i>				
Sandwich.....	58	-22	19.9	1.30	Snelling, Fort.....	38	-28	7.3	0.98
South Evanston.....	56	-21		1.94	<i>Missouri.</i>				
Sycamore.....	53	-24	17.0	1.54	Carthage.....	60	-10	31.5	0.90
Windsor.....	54	-9	23.1	1.85	Centerville.....	66	-6		2.42
<i>Indian Territory.</i>					Central College.....	60	-8		0.79
Gibson, Fort.....	69	-3	34.0	0.04	Conception.....	55	-18	19.6	1.70
Supply, Fort.....	69	-5	31.4	0.00	<i>Montana.</i>				
<i>Indiana.</i>					Keogh, Fort.....	55	-30	19.0	0.34
Butlerville.....	63	-4	27.1	3.22	Missoula, Fort.....	50	-3	32.0	1.90
Fort Wayne.....	64	0	26.0	1.91	<i>Nebraska.</i>				
Jeffersonville.....	60	4	29.1	2.52	Brownville.....	54	-8	22.0	1.00
Laconia.....				2.17	Crete.....	57	-11	18.0	0.57
La Grange.....	52	-5	19.4		De Soto.....	49	-13	16.4	1.58
Logansport.....	57	-17	24.2	2.85	Fremont.....	52	-12	18.2	1.03
Lafayette.....	59	-17	22.5	1.96	Genoa.....	59	-14	17.0	1.22
Manly.....	58	-5	20.4	3.14	Hay Springs.....	50	-13	19.9	0.60
Monticello.....	55	-14			Marquette.....				1.13
Sanman.....	53	-3	25.1	2.70	Niobrara, Fort.....	62	-18	19.1	0.80
Vevay.....	60	-4	29.6	2.89	Sidney, Fort.....	57	-3	28.0	0.33
					Stockham.....				0.41
					Tecumseh.....	57	-8	22.0	2.00

*Meteorological record of voluntary observers, etc.—Continued.*

Stations.	Temperature.				Stations.	Temperature.			
	Maximum.	Minimum.	Mean.	Rainfall.		Maximum.	Minimum.	Mean.	Rainfall.
<i>Nebraska.</i>	°	°	°	Inches	<i>Pennsylvania.</i>	°	°	°	Inches
Carson City.....	64	16	40.8	0.72	Altoona.....	53	8	31.6	0.99
McDermitt, Fort.....	50	18	37.4	2.52	Blooming Grove.....	50	0	18.4	2.40
<i>New Hampshire.</i>					Bethlehem.....	49	4	26.7	3.66
Antrim.....				4.35	Catawissa.....	52	0	26.0	2.36
Ashland.....				4.40	Drifton.....	50	1	21.8	2.04
Belmont.....				4.50	Dyberry.....	44	1	21.5	2.32
Berlin Mills.....	49	-22		2.99	Easton.....				3.80
Bristol.....				4.05	Fallington.....	50	7	26.4	3.50
Lake Village.....				4.75	Franklin.....	40	0	18.2	3.36
Nashua.....	49	1	23.9	4.51	Gramplan Hills.....	46	0	21.5	2.94
Wier's Bridge.....				4.26	Meadville.....	50	8	27.3	
Wolborough.....				5.00	Phillipsburg.....	47	-10	22.3	4.80
Woodstock.....				4.25	Quakerstown.....	49	6	25.9	2.43
<i>New Jersey.</i>					Wellsborough.....	45	-6	23.9	1.50
Beverly.....	53	6	28.3	3.35	West Chester.....	50	6	27.5	4.88
Clayton.....	60	3	28.0	3.80	Wilkesbarre.....	52	0	24.7	2.27
Moorestown.....	53	3	28.3	4.01	Wysox.....	45	0	22.0	1.08
Paterson.....	50	10	28.0	1.93	Zionsville.....	42	12	26.9	1.24
Readington.....	54	12	32.4		<i>South Carolina.</i>				
Roseland.....	50	-2		3.22	Aiken.....	66	20	45.0	3.77
South Orange.....	48	14	28.9	3.55	Kirkwood.....	60	19	39.7	2.19
Upper Montclair.....	51	3	26.8	1.62	Palestine.....	56	17	37.0	2.99
<i>New Mexico.</i>					Spartanburg.....	46	34	39.0	4.55
Bayard, Fort.....	77	23	46.0	0.00	Stateburg.....	65	22	43.9	2.50
Gallinas Spring.....	74	22		0.25	<i>Tennessee.</i>				
Selden, Fort.....	72	17	44.6	0.00	Ashwood.....	61	5	33.0	3.41
Union, Fort.....	69	8	38.4	0.45	Milan.....	64	11	34.2	2.22
Wingate, Fort.....	57	14	37.1	0.10	<i>Texas.</i>				
<i>New York.</i>					Austin.....	74	20	51.9	0.19
Auburn.....	47	-3	24.2	2.95	Cleburne.....	78	14	41.0	0.05
Brooklyn.....	62	12	27.2		Comfort.....				0.20
Cooperstown.....	46	-3	21.0	2.00	Concho, Fort.....	75	8	46.0	trace
Factoryville.....	46	-4	22.3	0.77	Corsicana.....				0.24
Humphrey.....	44	-6	20.1	2.67	Midland.....	70	11	42.4	
Ithaca.....	48	-4	23.6	1.61	Midland, Fort.....	84	22	57.9	0.00
Le Roy.....	46	-8	21.0	0.88	New Ulm.....	79	18	52.7	0.97
Madison Barracks.....	45	-16	19.7	1.88	Ringgold, Fort.....	87	25	60.3	trace
Menand.....	44	-1	21.6	1.89	Silver Falls.....	73	8		trace
Niagara, Fort.....	48	-1	24.9	1.00	<i>Vermont.</i>				
North Volney.....	45	-7	21.5		Barlinton.....	48	-12	20.2	1.70
Palermo.....	43	-14	19.3	2.97	Charlotte.....	40	-10	18.0	2.20
Penn Yan.....				1.51	Lunenburg.....	44	-18	15.4	3.40
Setauket.....	56	11	30.6	4.43	Newport.....	42	-24	15.0	2.81
West Point.....	54	5	26.3	3.00	Post Mills.....	38	-22	1.33	2.70
White Plains.....	51	10	27.8	2.19	Poultney.....	53	-15	18.0	2.10
<i>North Carolina.</i>					Stratford.....	44	-14	17.3	2.70

5th, with positive values; on the 7th, with positive and negative values.

At Baltimore, Maryland, a continuous photographic record has been obtained. Fluctuations during rain are marked on several sheets. The record for forty-eight hours from noon of December 4th to noon of December 6th includes the first snow storm of the season. Beginning at 2.05 p. m. of the 4th the potential continues positive, averaging 100 volts, with a sudden fall almost to zero about 7 p. m.; becoming positive again, slightly higher than before, until about 10 p. m. when the value is doubled, continuing until shortly before midnight when great fluctuations begin, extending to 500 volts on each side of zero, and continuing until 2.30 a. m. High positive values prevail until 7 a. m., decreasing steadily from that time, and become slightly negative about 12 m. of the 5th. Very high positive values prevailed from 12.30 p. m. to 1.45 p. m., followed by variable indications turning to negative, reaching a maximum, 300 volts, shortly after 5 p. m., or about the time the snow ended. It is to be noted that here, as at the other stations, positive electricity predominates during snow. Fluctuations of 1,000 volts on each side occur, during rain, from 10.40 a. m. to 10.50 p. m. of December 15th.

At Columbus, Ohio, negative values occurred on the following dates: on the 9th, in value 3 volts, during smoke almost as thick as fog. This is quite an exceptional instance, as no negative values are recorded for some time preceding and following, and as there appears to be no change in the weather with which this might be connected. On December 13th, negative values occurred during light rain; on the 22d, during light snow; on the 23d, during light rain, and on the 24th, during rain and snow. Snow occurred on November 30th, accompanied with positive values; on December 1st, with positive values; on the 17th, with high positive values; on the 22d, with negative values, and on the 24th, with negative values. The highest positive values were 136 volts on November 30th, during fair weather; 70 volts on December 2d, during clear weather; 92 volts on December 17th, during light snow, and 155 volts on December 29th, during fair weather. Zero potentials occurred on the 14th and 15th, during rain. The highest negative values occurred on the 24th, during snow.

At New Haven, Connecticut, negative values were obtained on the following dates: December 7th, at 9 a. m., value 8.8 volts, during cloudy weather, with high northeasterly winds, and preceding snow two hours. December 13th, at 1 p. m., value 57 volts, during light rain, which continued for some time. December 15th, at 1 p. m. and 3 p. m., during light rain, and preceding snow. December 18th, at 9 a. m. and 11 a. m., during light rain which continued for some time after last observation.

Rain occurred on the 13th, 15th, 18th, and 24th, the last being the only date not accompanied by negative values. The value during the rain, which ended soon after, was 23 volts positive. Snow occurred on December 7th, with values changing from minus 7 volts to plus 540 volts; on December 16th, with high positive values, and on the 27th, with low positive values.

The highest positive values occurred on December 7th, 540 volts, during heavy snow; on the 9th, 93.7 volts, during clear and cloudless weather; on the 10th, 67 volts, during clear weather; on the 16th, 1,307 volts, during light snow, 957, during heavy snow; and on the 17th, 102 volts, during clear weather. The values nearest zero occurred on the 15th, minus 5 volts, during light rain.

The highest negative values were 57 volts on the 13th, during light rain; 688 volts on the 15th, during light rain, and 108.5 volts on the 18th, during light rain. Dense fog is recorded on the morning of the 24th, accompanied with positive electrification, in value 60 volts, the average value for the remainder of the day being 22.6 volts.

At Boston, Massachusetts, a complete set of observations has been obtained. Negative indications occur on the following dates: December 4th, under circumstances to be men-

tioned later; on December 6th, following snow, during cloudy weather, on the same date in the afternoon, preceding snow by twelve hours; on the 12th, during cloudy weather, preceding rain seven hours; on the 15th, preceding snow twelve hours; on the 18th, preceding rain two and a half hours; on the 20th, during fair weather; on the 23d, preceding rain nine hours; on the 24th, preceding rain four hours; on the 26th, preceding snow two hours; on the 29th, preceding snow twelve hours; on the 30th, during snow, changing to positive; on the 31st, during snow.

Snow occurred on the 5th, accompanied by high positive potentials, increasing during the day; on the 7th, early in the morning, accompanied throughout the day by high positive potentials; on the 15th, at 11.30 a. m., and all day on the 16th, accompanied by high increasing positive potentials; on the 26th, beginning at 11 a. m. and ending at 12.30 p. m., high negative values, changing with the snow to high positive; on the 27th, from 10 a. m. to 1.15 p. m., accompanied by increasing positive values; on the 30th, from early in the morning throughout that day and the following, high negative changing to high positive values, becoming negative for a few hours on the 31st. There are at least three instances in which the coming snow might have been predicted from the indications of the electrometer, viz., on December 6th, 15th, and 29th.

Rain on the 12th was preceded by negative values, and accompanied on the 13th by low positive values. Likewise on the 18th and 24th negative indications preceded the rain sufficiently long to be of practical benefit. The highest positive potentials occurred on the 16th, 405 volts, during heavy snow, and on the 29th, 343 volts, during fair weather. In no case yet has the highest positive value obtained during fair weather exceeded or equalled that obtained during snowfall.

On three dates polar bands were observed, and the behaviour of the electrometer during their prevalence is most interesting. On December 4th the values were at 9 a. m., positive 75; at 11 a. m., positive 142.5; at 1 p. m., minus 226.5; and at 3 p. m., positive 257 volts. There were no noticeable changes in the weather. Polar bands were noticed from 3.30 p. m. to 6 p. m. On the 11th and 14th there are also marked variations in the potential during the continuance of polar bands.

At Ithaca, New York, observations have been continued during the month with the following results: on November 30th, during light snow, negative electricity was followed by heavy snow and positive values; on December 2d very high but variable negative indications occurred in advance of snow, with a change to increasing positive values during the snow; on December 3d negative values, snowing at intervals; on December 4th very high positive values in the forenoon, during snow, decreasing after snow ended, and in the afternoon, during cloudy weather, negative values; on December 5th negative values, during snow; on December 6th negative during light snow, positive after the snow ended; on December 7th negative in advance of snow, decreasing during snow; on December 9th small negative values in the morning, during calm cloudy weather; on December 13th negative values in the morning during threatening weather; on December 14th negative in the morning during threatening weather; on December 16th negative throughout the day, with snow in the forenoon; on December 18th negative during rain; on the 19th negative during snow but decreasing in value; on the 23d negative during threatening weather; on the 25th, in the morning, snow with high positive values, followed by threatening weather and high negative values, followed still later by snow and high negative values; on the 27th positive values during snow, with negative values after the snow had ended; on the 28th negative values during calm fair weather.

Snow, accompanied by high positive values, is recorded on December 15th, 22d, and 26th. December 5th is the most noteworthy of the dates on which snow fell accompanied by negative values; and even this seems to show a decrease in the negative electrification during snow. The values for the



different observations were respectively, —150, —5, —525, and —324 volts, the snow beginning a little before, and ending a little after the last observations.

These observations at Ithaca seem to strongly confirm the statement first made by Wislizenus, and subsequently hinted at by many observers, that a negative value, during winter months and under certain conditions of weather, is almost always an indication of snowfall within a certain distance of the place of observation.

During the snowfall at the place of observation the values are, as a rule, positive, and increasing during the continuance of the snow, or, if negative, the values decrease with the continuance of snow, which is virtually the same condition.

The highest positive values occurred on the following dates, with, in every case, close connection with snow: On 2d, value 800 volts, during light snow; on 3d, value 1,200 volts, during light snow; on 4th, 2,200 volts, during light snow; on the 15th, 2,270 volts, during light snow, 2,500 volts, during heavy snow, 960 volts, during light snow; on the 25th, 615 volts, during light snow; on the 26th, 1,550 to 2,000 volts, during light snow; on 27th, 2,300 volts, following snow one hour.

The values nearest zero were as follows, marked, as a rule, by cloudy, threatening weather: On November 29th, 7 volts, during threatening weather; on December 5th, 35 volts, during threatening weather; on the 7th, 5 volts, and on the 16th, 0 to —10 volts, during threatening weather; and on the 19th, 0 volts, during threatening weather. It may be of interest to note that for the first date given rain followed in twelve hours; on the second date snow followed in three hours; on the third date snow followed in one hour and fifty minutes; and on the fourth date snow followed in thirty minutes. For the 19th no precipitation is recorded within forty hours, although the weather remained for some time threatening and cloudy.

The highest negative values occurred on December 14th, 350 volts, during threatening weather, preceding snow twelve hours; on December 16th, 400 volts, during light snow, which soon ended; on December 18th, 668 volts, during light rain; and on December 25th, during light snow.

On chart vi is plotted the observations made during the month of December, 1886, at Boston, Ithaca, and New Haven. The observations for the present are made at 9 a. m., 11 a. m., 1 p. m., and 3 p. m. In the case of Boston, considering the curve generally, we notice that there are four periods of marked fluctuation, namely, December 5–6th, December 15–16th, December 25th, and December 29th. All these are found to correspond with certain atmospheric disturbances, and it is very evident that these fluctuations are closely connected with the movements of storm-areas. In this special case, the dates mentioned above are dates of heavy snow at Boston. To some extent there is an agreement between the dates of marked fluctuation at Boston and Ithaca, and there seems to be, as might be anticipated, a certain time difference between the two places. Thus, at Ithaca, the highest positive values on the 4th and 15th appear to precede by some hours the highest positive values obtained at Boston. But the snow began at Ithaca on 4th at 7.45 a. m., while it did not begin at Boston until 8.15 a. m. of the 5th, and on the 15th snow began at Ithaca during the early morning while it did not begin at Boston until 11.30 p. m. of the 15th; or the time difference between certain electrometer indications at two places is connected with their distance from the disturbing influences.

#### OPTICAL PHENOMENA.

##### SOLAR HALOS.

Solar halos were observed in the various states and territories on the following dates:

*Arizona*.—4th, 6th, 16th, 28th.  
*California*.—1st, 3d, 4th, 10th, 15th, 16th, 22d, 28th, 31st.  
*Colorado*.—2d, 5th, 9th, 12th.  
*Dakota*.—1st to 4th, 6th, 11th, 23d, 26th, 27th, 29th, 31st.  
*Florida*.—4th, 8th, 25th, 28th.  
*Georgia*.—29th, 31st.

*Idaho*.—21st.  
*Illinois*.—3d, 7th, 11th, 15th, 16th, 20th, 22d, 23d, 25th, 27th, 28th, 30th.  
*Indiana*.—2d.  
*Iowa*.—3d, 27th, 29th.  
*Kansas*.—1st, 13th, 21st, 22d, 23d, 27th, 28th, 29th, 31st.  
*Kentucky*.—3d.  
*Maine*.—22d, 24th, 30th.  
*Massachusetts*.—4th, 10th, 27th.  
*Michigan*.—7th, 8th, 10th, 11th, 17th, 18th, 20th, 22d, 25th, 27th, 28th, 30th.  
*Minnesota*.—1st to 4th, 11th, 14th, 20th, 22d, 23d, 26th, 27th, 29th.  
*Missouri*.—19th.  
*Montana*.—3d, 5th, 25th, 29th.  
*Nebraska*.—30th, 31st.  
*Nevada*.—26th.  
*New Hampshire*.—6th.  
*New Jersey*.—3d, 4th, 26th, 28th, 29th.  
*New York*.—5th, 10th, 16th, 17th, 23d, 28th, 29th, 30th.  
*North Carolina*.—1st, 8th, 9th, 12th, 14th, 17th, 19th, 24th, 28th.  
*Ohio*.—4th, 7th, 10th, 15th, 20th, 25th, 26th, 28th, 30th.  
*Oregon*.—18th, 20th.  
*Pennsylvania*.—17th, 23d.  
*South Carolina*.—8th, 9th, 28th, 29th.  
*Tennessee*.—8th, 9th, 18th, 20th, 25th, 26th.  
*Texas*.—7th, 27th.  
*Vermont*.—10th, 23d, 30th.  
*Virginia*.—9th, 19th.  
*Wisconsin*.—1st, 11th, 18th, 24th, 27th to 30th.  
*Wyoming*.—1st, 2d, 5th, 11th, 15th, 21st.

##### LUNAR HALOS.

Lunar halos were observed in the various states and territories on the following dates:

*Alabama*.—7th, 8th, 9th.  
*Arizona*.—3d to 9th, 28th, 29th.  
*Arkansas*.—7th, 8th, 10th.  
*California*.—1st to 5th, 10th, 11th, 15th, 30th, 31st.  
*Colorado*.—6th, 9th.  
*Connecticut*.—4th, 10th.  
*Dakota*.—2d, 6th, 7th, 9th, 10th, 15th.  
*District of Columbia*.—11th.  
*Florida*.—4th, 7th, 8th, 9th, 17th, 30th.  
*Georgia*.—7th, 8th, 9th, 31st.  
*Idaho*.—2d, 4th, 6th, 10th, 19th.  
*Illinois*.—3d, 6th, 10th, 11th, 14th, 15th, 28th, 30th, 31st.  
*Indiana*.—3d, 6th, 7th, 11th, 18th.  
*Indian Territory*.—7th, 10th.  
*Iowa*.—3d, 6th, 9th, 11th, 13th, 19th, 20th, 31st.  
*Kansas*.—1st, 2d, 3d, 5th, 6th, 9th, 10th, 15th, 16th, 18th, 22d, 29th, 31st.  
*Kentucky*.—3d, 4th, 8th.  
*Louisiana*.—7th, 30th.  
*Maine*.—4th, 6th, 7th, 11th, 29th.  
*Maryland*.—11th.  
*Massachusetts*.—4th, 6th, 10th, 11th, 18th.  
*Michigan*.—4th, 5th, 7th to 10th, 17th, 29th, 30th.  
*Minnesota*.—1st, 5th, 6th, 8th, 9th, 14th, 16th, 17th.  
*Mississippi*.—7th.  
*Missouri*.—6th.  
*Montana*.—5th, 7th, 9th, 12th, 29th.  
*Nebraska*.—6th, 7th, 9th, 10th, 11th, 13th, 31st.  
*Nevada*.—1st, 6th, 10th.  
*New Hampshire*.—4th, 6th, 10th, 14th, 19th.  
*New Jersey*.—4th, 7th, 11th, 14th, 26th.  
*New Mexico*.—6th.  
*New York*.—4th, 5th, 10th, 11th, 28th.  
*North Carolina*.—3d, 4th, 8th, 9th, 13th, 30th.  
*Ohio*.—1st, 2d, 7th, 8th, 11th, 15th, 17th, 30th.  
*Oregon*.—1st, 4th, 5th, 7th, 30th.

*Pennsylvania.*—4th, 11th, 12th, 19th.  
*Rhode Island.*—4th.  
*South Carolina.*—3d to 8th, 9th, 10th, 13th.  
*Tennessee.*—3d, 6th, 7th, 8th, 9th.  
*Texas.*—5th to 8th, 10th, 12th, 17th.  
*Utah.*—4th, 5th, 6th, 8th.  
*Vermont.*—7th.  
*Virginia.*—3d, 7th, 9th, 11th, 13th, 14th, 19th.  
*Washington Territory.*—1st, 6th, 10th, 30th.  
*West Virginia.*—2d, 6th, 7th, 8th, 11th.  
*Wisconsin.*—1st, 4th, 6th, 8th, 9th, 10th, 20th, 29th.  
*Wyoming.*—2d, 6th, 9th, 15th, 30th.

The phases of the moon (Washington mean time) during December, as given in "The American Ephemeris and Nautical Almanac" for 1886, are as follows: New moon, 24th, 16 h. 46.5 m.; first quarter, 2d, 21 h. 16.8 m.; full moon, 10th, 16 h. 22.0 m.; last quarter, 17th, 13 h. 30.9 m.; apogee, 2d, 21.8 h. and 30th, 19.1 h.; perigee, 15th, 6.9 h.

#### MIRAGE.

Fort Assinaboine, Montana: the phenomenon of mirage appeared twice during the 11th. It was first seen during the morning from 8.20 to 8.55, local time. The Fort Belknap Indian agency, twenty-eight miles north of Fort Assinaboine, was plainly visible. Objects appeared magnified to immense proportion and were not inverted but in their proper position. The agency appeared to be surrounded by a dense forest although it is really situated in the midst of an open prairie, but some timber along the Milk River between this place and the agency may explain the appearance of forest. The second mirage was visible towards the west during the greater part of the afternoon; two small lakes, sixteen miles distant and ordinarily hidden from view by a range of high bluffs on the west side of Little Sandy Creek, were plainly visible, the water having a wavy motion, as if stirred by the wind. The sun was shining brightly at the time of both observations.

The following is from the "Independent" of December 18, 1886, published in Inyo, California:

On the morning of the 11th, from the road just south of Independence, California, a very beautiful mirage was seen. A low ridge, about three miles south of the town, shuts off the view of Owens Lake, about twenty-two miles away. In the mirage the whole surface of the lake was seen, with islands and headlands. The mountain on the northeast corner of the lake appeared to come close down to the water, and was as clearly reflected in its depth as in a mirror. Indeed, the entire surface of the phantom lake looked like a great mirror in which the mountains on both sides were reflected.

Saint Vincent, Minnesota: at 7.30 a. m. of the 26th the phenomenon of mirage was seen to the south, the images of trees, houses, barns, etc., were lifted into view.

Mirages were also observed at the following places:

*Arizona.*—Maricopa, 16th.  
*Dakota.*—Webster, 4th; Henry, 7th.  
*Kansas.*—Salina, 4th, 6th, 9th, 13th, 14th.  
*Montana.*—Poplar River, 8th.

#### MISCELLANEOUS PHENOMENA.

##### FOREST AND PRAIRIE FIRES.

Charleston, South Carolina: extensive and destructive forest fires were burning on the 1st between this city and Sumter, along the line of the Central Railroad of South Carolina. At Monck's Corner, thirty-one miles from Charleston, many plantation buildings are reported to have been destroyed. At Stony Landing one hundred cords of wood and other property were destroyed.

Forest and prairie fires were also reported from the following places:

Wilmington, North Carolina: forest fires, 2d, 3d.  
 Alva, Florida: forest fires, 27th.  
 Fort Sill, Indian Territory: prairie fires, 14th, 18th.  
 Fort Reno, Indian Territory: prairie fires, 17th.  
 San Antonio, Texas: prairie fires, 21st.

##### METEORS.

Fall River, Massachusetts: on the 9th, at different times be-

tween 8 p. m. and midnight, numerous meteors were observed starting from near the zenith and passing westward, several of them were followed by bright trains, and a few exploded with a loud report.

At 9 p. m. of the 11th, Geo. W. Smith, master of the schooner "S. B. Vrooman," from Port of Spain, Trinidad, for Mobile, Alabama, in N. 13° 25', W. 65° 55', observed a large meteor passing from south to north, emitting a brilliant light for thirty seconds, and then exploding with a report that jarred the schooner.

Nashua, Hillsborough county, New Hampshire: at 6.09 p. m. of the 14th a meteor, having an apparent diameter of six inches, and followed by a train of red light, was seen to start from near the zenith and pass toward the northeastern horizon.

Grampian Hills, Clearfield county, Pennsylvania: on the 21st, at 7.30 p. m., a large meteor was seen in the western sky 45° above the horizon, and moving toward the south; it resembled a ball of fire, having an apparent diameter of six inches, and followed by a trail of light. The meteor disappeared when at an elevation of about 25°.

Meteors were also observed on the following dates:

*California.*—Keeler, 19th.  
*Connecticut.*—Bethel, 28th.  
*Florida.*—Archer, 18th; Alva, 19th, 27th.  
*Illinois.*—Geneseo, 6th; Charleston, 19th.  
*Iowa.*—Monticello, 22d.  
*Kansas.*—Salina, 4th, 5th, 7th, 9th.  
*Louisiana.*—Grand Coteau, 12th, 13th, 22d.  
*Maryland.*—Woodstock, 2d, 3d, 11th, 16th, 19th, 21st.  
*Nebraska.*—Valentine, 10th.  
*Ohio.*—Wauseon, 19th, 25th, 29th; Jacksonborough, 21st.  
*South Carolina.*—Spartanburg, 24th, 25th.  
*Virginia.*—Variety Mills, 3d.

#### MIGRATION OF BIRDS.

*Geese flying southward.*—Augusta, Georgia, 2d; Chattanooga, Tennessee, 2d; Ninneseah, Kansas, 5th; Brownville, Nebraska, 25th, 28th, 29th; De Soto, Nebraska, 22d; Tatoosh Island, Washington Territory, 9th, 14th, 30th; Albany, Oregon, 8th, 9th, 11th, 30th; East Portland, Oregon, 20th, 22d.

*Geese flying northward.*—Fort Madison, Iowa, 20th; De Soto, Nebraska, 10th.

#### POLAR BANDS.

Polar bands were reported from the following stations:

*Colorado.*—Montrose, 12th.  
*Connecticut.*—Bethel and North Colebrook, 4th.  
*Florida.*—Archer, 3d, 25th, 27th, 28th, 29th.  
*Illinois.*—Riley, 11th.  
*Kansas.*—Ninneseah, 6th, 20th, 29th; Salina, 13th, 29th.  
*Maine.*—Gardiner, 4th, 23d.  
*Ohio.*—Napoleon, 7th, 9th, 10th, 11th, 15th, 22d, 25th, 27th, 28th; Wauseon, 10th, 15th, 20th, 25th.  
*Tennessee.*—Chattanooga, 7th; Nashville, 8th.  
*Texas.*—Abilene, 10th.  
*Virginia.*—Wytheville, 9th, 14th, 19th; Dale Enterprise, 19th.

*Wisconsin.*—Prairie du Chien, 2d, 3d; Milwaukee, 8th.

#### SUN SPOTS.

Mr. H. Govey, of North Lewisburg, Champaign county, Ohio, reports having observed sun spots on the following dates: 11th, 16th, 18th, 20th, 27th, 29th.

#### WATER-SPOUTS.

Capt. L. Dexter, commanding the s. s. "City of Para," reports having observed several water-spouts, between 7 a. m. and 12 noon of the 2d, in N. 37° 38', W. 73° 40' (at noon).

The following is from the "New York Herald" of December 18, 1886:

NEW ORLEANS, December 17.—The British ship "Struan," from Rio Janeiro, reports having encountered, just south of the Mississippi, an enormous collection of water-spouts. The sky was cloudy and the air thick, but the fog suddenly cleared away and showed that the vessel was surrounded by an in-



definite number of water-spouts, some of them unusually large. There were eighteen in the immediate vicinity of the vessel, and two came so close that it was necessary to change the course in order to escape them. The spouts were shortly after swept away by a whirlwind.

Capt. R. B. Quick, of the s. s. "Eureka," reports having observed a large water-spout on the 22d, in N. 31° 32', W. 79° 10' (at noon).

#### VERIFICATIONS.

##### INDICATIONS.

The predictions for December, 1886, were made by 2d Lieutenant John C. Walshe, Signal Corps, U. S. Army, Assistant, and were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant.

The detailed comparison of the tri-daily indications for December, 1886, with the telegraphic reports of the twenty-four hours for which the indications were prepared, shows the general average percentage of verifications to be 68.80. The percentages for the different elements are: Weather, 71.21; wind, 66.12; temperature, 66.47. By states, etc., the percentages are: For Maine, 67.07; New Hampshire, 69.49; Vermont, 60.60; Massachusetts, 67.53; Rhode Island, 67.98; Connecticut, 65.38; New York, 72.85; Pennsylvania, 69.84; New Jersey, 70.94; Delaware, 69.14; Maryland, 73.41; District of Columbia, 71.51; Virginia, 72.74; North Carolina, 74.30; South Carolina, 72.80; Georgia, 74.76; Florida, 70.00; Alabama, 66.69; Mississippi, 65.65; Louisiana, 65.91; Texas, 64.78; Arkansas, 63.78; Tennessee, 64.95; Kentucky, 67.04; Ohio, 74.35; West Virginia, 67.87; Indiana, 71.90; Illinois, 72.77; Michigan, 71.99; Wisconsin, 68.05; Minnesota, 68.55; Iowa, 68.71; Kansas, 64.84; Nebraska, 60.86; Missouri, 72.58; Colorado, 65.24; east Dakota, 57.82.

There were three omissions to predict, out of 9,951, or 0.03 per cent. Of the 9,948 predictions that have been made, 1,193, or 11.99 per cent., are considered to have entirely failed; eight hundred and thirty, or 8.34 per cent., were one-fourth verified; 1,892, or 19.02 per cent., were one-half verified; 1,715, or 17.24 per cent., were three-fourths verified; 4,318, or 43.41 per cent., were fully verified, so far as can be ascertained from the tri-daily reports.

Below are given for the Pacific coast the percentages of indications verified for November, 1886; this data was received too late for publication in the November REVIEW. The predictions were made by 2d Lieutenant W. A. Glassford, Signal Corps, U. S. Army, Assistant; they were verified by 2d Lieutenant Frank Greene, Signal Corps, U. S. Army, Assistant. The percentages for the different districts are: Washington Territory, 62.79; Oregon, 68.08; northern California, 78.37; southern California, 86.01.

##### CAUTIONARY SIGNALS.

Of the total number of signals ordered during December, 1886, it was practical to determine the verifications of one hundred and seventy-one; of these, eighty-eight, or 51.46 per cent., were fully verified both as to direction and velocity. Number of signals ordered for northeast winds, thirty-seven; verified both as to direction and velocity, seventeen, or 45.95 per cent. Number of signals ordered for southwest winds, twenty; verified both as to direction and velocity, one, or 5.00 per cent.; verified as to velocity only, one, or 5.00 per cent. Number of signals ordered for northwest winds, ninety; verified both as to direction and velocity, sixty-one, or 67.78 per cent.; verified as to velocity only, three, or 3.33 per cent. Number of signals ordered for winds without regard to direction, twenty-four; verified, nine, or 37.50 per cent. Number of signals ordered late, *i. e.*, after the verifying velocity had begun, four, or 2.34 per cent.

In thirty-nine instances winds were reported which would have justified the display of cautionary signals, but for which no signals were ordered, and in twelve instances winds which would have justified the display of on-shore signals, but for which no signals were ordered.

In addition to the above, four hundred and twenty-seven sig-

nals were ordered at display stations, the verifications of which it was impracticable to determine.

##### COLD-WAVE SIGNALS.

Total number of cold-wave signals ordered, the verifications of which were determined, was three hundred and fourteen; verified, two hundred and eight, or 66.24 per cent. Seventy-seven signals were ordered, the verifications of which it was impracticable to determine. In addition to the above, in four hundred and ninety instances, the signals ordered at the regular stations were repeated by the observers to towns in their vicinity. The verifications of these it was impracticable to determine.

##### RAILWAY WEATHER SIGNALS.

P. H. Mell, jr., director of the "Alabama Weather Service," in the report for December, 1886, states:

The verification of predictions for the whole area was 96 per cent. for temperature, and 87 per cent. for weather.

The following corporations comprise this system: South and North; Montgomery and Mobile; Mobile and Girard; Georgia Pacific; East Tennessee, Virginia and Georgia system in Alabama; Memphis and Charleston; Columbus and Western; Atlanta and West Point of Georgia; Northeastern of Georgia; Western and Atlantic; East Tennessee, Virginia and Georgia system in Georgia; Montgomery and Eufaula; Pensacola and Selma; Pensacola and Atlantic; the cities of Milledgeville, Georgia, and Talladega, Alabama.

The following is from the "Bulletin of the New England Meteorological Society" for December, 1886:

Verification of weather signals at New Haven was 68 per cent. for temperature, 84 for weather; at six stations reporting to the Signal Office in Boston, 85 for temperature, 74 for weather.

##### SUNSET PREDICTIONS.

The characteristics of the sky, as indicative of fair or foul weather for the succeeding twenty-four hours, have been observed at all Signal Service stations. Reports from one hundred and fifty-nine stations show 4,922 observations to have been made, of which six were reported doubtful; of the remainder, 4,916, there were 4,376, or 89.0 per cent., followed by the expected weather.

##### STATE WEATHER SERVICES.

The following is an extract from the December, 1886, report of the "Alabama Weather Service," P. H. Mell, jr., of the Agricultural and Mechanical College, Auburn, director:

The most remarkable feature of the month was the heavy precipitation of snow over all parts of the state on the 3d to 5th. Throughout north Alabama 17 to 20 inches of snow fell between the morning of the 3d and the evening of 5th. In middle Alabama 12 to 16 inches were reported during the same period; and in south Alabama as much as 12 inches were reported from several stations. This fall of snow is unusually heavy for this climate, and in some sections was the cause of marked comment, because such a sight had never been witnessed before, especially in the extreme southern part of the state.

The cold waves that were predicted by the Chief Signal Officer on the 1st, 17th, 24th, 26th, and 31st were verified with satisfactory accuracy. It is worthy of note that the frequency of these cold waves over the state during the month has reduced the average temperature 7° 2 below the normal, giving quite a cold winter month for Alabama.

There was a deficiency of precipitation amounting to 1.88 inches.

##### Summary.

Mean temperature, 43°; highest temperature, 76°, at Mount Willing, on the 12th; lowest temperature, 0°, at Valley Head, on the 7th; range of temperature, 76°; greatest monthly range of temperature, 62°, at Mount Willing; least monthly range of temperature, 39°, at Oswichee; mean daily range, 18° 4; greatest daily range of temperature, 46°, at Eufaula, on the 22d; least daily range of temperature, 0°, at Livingston, on the 5th, Newton, on the 10th, and Tuscaloosa, on the 1st.

Mean depth of rainfall, 2.97 inches; mean daily rainfall, 0.096; greatest depth of monthly rainfall, 5.20 inches, at Newton; least depth of monthly rainfall, 0.27 inch, at Bermuda; greatest daily local rainfall, 2.20 inches, at Mount Willing, on the 5th.

Average number of days on which rain fell, 7; average number of cloudy days, 13; average number of fair days, 9; average number of clear days, 9.

Warmest days, 23d, 28th; coldest days, 7th, 16th.

Prevailing direction of wind, northwest.

##### Annual summary for 1886.

Mean temperature, 61° 6; highest temperature, 103°, August 18th, at Birmingham; lowest temperature, -7°, January 11th, at Gadsden; range of temperature, 110°; greatest daily range, 49°, February 23d, at Carrollton, and at Oswichee on November 1st; least daily range, 0°, on various dates and at several stations.

Number of clear days, 127; number of fair days, 117; number of cloudy days, 121; number of days on which rain fell, 258.

Mean rainfall, 54.63 inches; mean monthly rainfall, 4.54 inches; mean daily rainfall, 0.16 inch; greatest local monthly rainfall, 18.26 inches, in March, at Newton; least local monthly rainfall, 0.00, in October, at Auburn, Bermuda, Eufaula, Mount Willing, and Oswichee; greatest daily rainfall, 9.75 inches, on March 29th, at Russellville.

The following is an extract from the December, 1886, report of the "Colorado Meteorological Association," Charles F. Wilson, president; central office at Colorado Springs:

The collection and publication of information on the weather of Colorado is of such manifest public utility that the Meteorological Association last spring resolved to trust to the public-spirited citizens of the state for that appreciation of the enterprise upon which alone it must depend for its support. The arguments which have induced the citizens of other states to maintain similar services apply with undiminished force to Colorado. In respect to the advantages elsewhere gained, the report of a committee of the Franklin Institute, charged with the establishment of a weather service for Pennsylvania, says, under date of December 15, 1886:

"The state services already established have proved of the greatest value to the citizens, and have afforded material aid to the [U. S.] Meteorological Bureau in its efforts to extend its usefulness. While the stations of the Signal Service may be numerous enough for storm and frost warnings and general weather predictions, they are not sufficient to determine the climatic conditions of our state sufficiently for the best scientific and practical results. They are mere outposts for general work, so far apart that numberless meteorological phenomena occur, that being unrecorded, are lost for comparison and study. The value of systematic and continuous records of atmospheric changes cannot be overestimated. There is not an industry in the country that could not be profited by them."

The following is an extract from the December, 1886, "Monthly Review of the Illinois Weather Service," Col. Charles P. Mills, of Springfield, director:

**Temperature.**—The mean temperature of the state for the month, 22°.0, was 5°.2 below the normal for the past twelve Decembers. The mean temperature of the northern counties was 18°.0; of the central counties, 21°.8; and of the southern counties, 26°.9.

The temperature was from 3° to 8° below the normal December temperature at all stations reporting, Decembers of 1876 and 1880, alone, were colder in past twelve years.

The cold wave of the 27th lowered the December record of minimum temperature by 5°. It was severe as far south as the thirty-ninth parallel.

The highest temperature during the month, 64°, was reported from Bloomington, McLean county, on the 11th; the lowest, —29°, from Elmira, Stark county, on the 27th.

**Precipitation.**—The average precipitation for the state for the month, 1.66 inches, was 1.08 inches below the normal December precipitation of the past eight years. The average for the northern counties, 1.19 inches, was 0.84 of an inch below; for the central counties, 1.44 inches, was 1.03 inches below; and for the southern counties, 2.38 inches, was 1.23 inches below. The precipitation was below the normal at all of the stations reporting, except Saint Louis, Missouri, where it was 0.19 of an inch above.

The departures below the normal ranged from 0.07 of an inch at White Hall, Greene county, to 2.46 inches at Golconda, Pope county.

The precipitation during December was less than any December since 1878, except, 1880, when it averaged only 0.08 of an inch less for the state.

The following is an extract from the December, 1886, report of the "Indiana Weather Service," Prof. H. A. Huston, of Purdue University, Lafayette, director:

Districts.	Temperature.			Average precipitation.
	Highest.	Lowest.	Monthly means.	
	°	°	°	Inches.
Northern counties .....	60.0	—13.0	22.3	2.04
Central counties .....	60.0	—17.0	22.9	2.64
Southern counties .....	66.0	—5.0	27.2	2.30
State .....	66.0	—17.0	24.1	2.33

The mean temperature of the state for December, 1886, was 5°.7 below the mean temperature of the last five years; 3°.9 below the mean of thirty-two years at Logansport; 8°.0 below the mean of sixteen years at Indianapolis; 10°.5 below the mean of twenty-one years at Vevay; 0°.7 below the mean of thirty-three years at Spiceland; 0°.9 below the mean of seven years at Maury; 8°.8 below the mean of nine years at Blue Lick; 6°.1 below the mean of five years at Worthington; 5°.2 below the mean of four years at Connersville; 2°.5 below the mean of seven years at Lafayette.

The temperature at the various stations was below the average, ranging from 0°.9 (at Worthington) to 6°.9 (at Indianapolis).

The mean precipitation of the state for December, 1886, was 1.16 inches below the mean of the past five years; 1.13 inches below the mean of thirty-two

years at Logansport; 1.04 inches below the mean of sixteen years at Indianapolis; 1.79 inches below the mean of twenty-one years at Vevay; 0.31 inch below the mean of twenty-six years at Spiceland; 1.61 inches below the mean of five years at Blue Lick; 1.39 inches below the mean of five years at Worthington; 1.43 inches below the mean of four years at Connersville; 1.22 inches below the mean of seven years at Lafayette.

The precipitation at various stations was below the average, ranging from 0.26 inch below (at Lafayette) to 1.63 inches below (at Worthington).

Every station but one reports the highest temperature of the month on the 11th, and, with a few exceptions, the lowest temperature is reported on the 3d.

Frosts are reported on every day except the 12th, 13th, 23d, 24th.

Fogs are reported on the 10th, 12th, 17th, 21st, 23d.

The following is from the advance bulletin for December, 1886, of the "Iowa Weather Service," Dr. Gustavus Hinrichs, director; central station at Iowa City:

December, 1886, was very cold, fair, and dry, with winds normal in direction and rather low in force.

The mean temperature of the air was over seven degrees below normal. During the past sixteen years it has but once been decidedly colder, namely, in 1876.

The middle decade of December, 1886, was normal in temperature, with rain and extended fog on the 11th and 12th, and cold with snow on the 15th and 16th. The first and last decades were very cold, averaging nearly eleven degrees below normal. The coldest days were the first and second, nearly thirty degrees below zero, and the thermometer remaining below throughout the state at noon. The next three days were also very cold, but only about twenty degrees below normal. The thermometer remained below zero at noon only in the northwest on the 3d and 4th, and reached above zero at noon on the 5th. The temperature of the 26th and 27th averaged fully twenty-five degrees below normal.

On these very cold days the run of the wind was comparatively light, so that the suffering produced was not extreme. At the central station, the run of the wind was not quite two hundred miles per day on the first and second, only one hundred and twenty miles per day on the 26th and 27th, and one hundred miles per day on the 3d to 5th.

The total number of very cold days, on which the temperature reaches to or falls below zero Fahrenheit, was eight, exceeding the average for December of the past ten years by two.

The warmest spell of the month comprises the four days from the 9th to the 12th, averaging fourteen degrees above normal in temperature, and marked by extended fogs or misty weather and very light rains. On the 11th the mean temperature was seventeen degrees above normal, while on the first it was thirty below normal, thus showing a difference of nearly fifty degrees in the mean temperature of these days.

The precipitation was light and mostly snow, falling on six to nine days in eastern Iowa, and on from three to five days in the western and central parts of the state.

The total amount of rain and melted snow averages less than half an inch for the interior parts of the state, and about an inch along the two great rivers.

#### Summary for the year 1886.

The year 1886 was extreme in temperature, very fair and dry, with but few severe storms, and a low aggregate run of the wind.

The mean temperature of the air for the entire year was nearly normal, exceeding this value by only a quarter of a degree. But the heat was very unequally distributed, the cold months being much colder, and the warm months of the year being much warmer than normal for each season. From the beginning of the year until April 10th, the temperature averaged nearly four degrees below normal; only one of these ten decades, namely middle March, was warmer than normal. From the eleventh of April until the tenth of November the temperature averaged three and one-third degrees above normal, and only three of the twenty-one decades comprised in this period were below normal. The balance of the year, from November 11th till the close of the year, was again quite cold, averaging five and a half degrees below normal, and every one of these five decades was separately below normal. Thus, the first ten and the last five decades of the year, comprising the winter months, were 4°.2 colder than normal, while the twenty-one decades, from the 11th of April until the 10th of November, and comprising the sowing and growing, the ripening and harvesting season, were 3°.4 warmer than normal.

The rainfall in Iowa was very low, less than two-thirds of the normal amount. It is by far the least yet observed since the organization of the weather service has made more reliable comparisons possible. The total rainfall of the year was greatest along the Missouri River, where it averaged thirty inches. In a broad belt running from Osceola to Wayne counties, the total rainfall increased from fifteen inches in the north to twenty-five inches in the south. In the belt from Kosuth over Marshall and Tama to Wapello counties, the rainfall was nearly the same throughout, averaging twenty-five inches. From here eastward to the Mississippi, the total rainfall varies in nearly the normal manner, but amounts to about ten inches less than usual.

The following is an extract from the December, 1886, report of the "Minnesota Weather Service," Prof. Wm. W. Payne, Carleton College, Northfield, director:

The mean temperature of the state for December was 7°.3, which is 12°.2 below that of the corresponding month of 1885. At Saint Paul it was 11°



below the average; Moorhead, 9°.3; Duluth, 7°; Saint Vincent, 5°.7; La Crosse, 5°.6. The month at Saint Paul was the coldest since 1876, while other stations report it the coldest since 1879. The coldest periods during the month were from the 1st to 4th, 15th to 16th, and from the 18th to the close of the month in the northwestern portion of the state; and from the 24th to the close in the eastern portion. During these periods the minimum temperature was daily below zero. The lowest temperature was 38°.3 below zero on the 26th at Saint Vincent. Six stations reported the minimum temperature over 30° below zero, while but two stations, La Crosse and Mankato, reported it higher than 20° below zero. The mean temperature for the month was below zero at Saint Vincent, Moorhead, and Alexandria, while in the December of 1885 no station reported the mean lower than 12° above. The lowest daily mean temperature was 25°.8 below at Moorhead, on the 26th; the lowest of the maxima temperatures was 19°.0 below, at the same station, on the 2d. The warmest period of the month was generally from the 7th to the 12th; the maximum temperature reported was 48°.0, on the 8th and 9th, at Winona and La Crosse. The greatest monthly range of temperature was 77°.0, at Grand Forks, while Saint Vincent followed closely with a range of 74°.5; the least monthly range was 62°.6, at Mankato; the range for the state was 86°.3.

The precipitation was slightly below the average and mainly in the form of snow. The greatest fall (in inches) was 1.87 and 1.48, at Spring Valley and Saint Paul, respectively; while at Moorhead the fall amounted to .53; Grand Forks and La Crosse, .50; Saint Vincent and Morris, .27.

#### Summary for 1886.

The winter was very severe. The temperature was below the average, and the precipitation slight. The lowest temperature for the year was 41°.5 below zero, at Park Rapids, on January 23d.

Spring was characterized by late frosts—which did considerable damage to vegetation—and by a slight rainfall.

Summer proved one of the driest and warmest since the country's settlement. The highest temperature for the year was 107°.0, at Sherburne.

Autumn was marked by a deficient rainfall and a temperature below the average.

In May, one of the severest droughts ever known in the northwestern portion of the State was inaugurated and continued until September, when it was broken. The effects of the decrease in rainfall were augmented by the unusually high temperature which prevailed, proving exceedingly disastrous to growing crops. The water in rivers, lakes, and sloughs became very low, and, in fact, disappeared in many localities, thus causing great trouble in obtaining the necessary supply for cattle.

The following is an extract from the December, 1886, report of the "Missouri Weather Service," Prof. Francis E. Nipher, Washington University, Saint Louis, director:

December, 1886, has been a cold month though not unusual for very low temperatures. The mean of the month was 28°.2, which is 5°.2 below the normal for December at Saint Louis. The minimum temperature, 2°.7, has often been exceeded in former years, when it has fallen as low as 11° below zero as early as December 11th (in 1882). The highest temperature obtained was 57°.5, which was observed on the 10th. The lowest temperature was observed on the 27th. The temperature fell to or below the freezing point on twenty-four days and did not rise above freezing on fifteen days during the month. The low temperatures occurred in the first and third decades, which two were nearly of the same temperature, the latter being but two-tenths of a degree colder than the former. The middle decade, however, was comparatively warm, its mean temperature being 35°.3, which is ten degrees above that of the first and third decades.

The mean temperature for December has been below that of the past month eight times since 1837, the lowest of which occurred in the Decembers of 1872 and 1876, both showing a mean of 23°.3.

The rainfall (and melted snow) was 3.04 inches, most of which fell on the 23d and 24th, when 2.07 inches fell in about twelve hours. The normal for December at Saint Louis is 2.97 inches.

In the state the rainfall has been very light, except in the southeast parts along the Mississippi River, where it has been near the normal, while in the central and northern parts it was less than one inch. The least rainfall is reported from Kirksville, being only 0.22 inch, and Steelville, 0.23 inch.

The following is an extract from the December, 1886, report of the "Ohio Meteorological Bureau," Prof. B. F. Thomas, of the Ohio State University, Columbus, president:

Our records for the month just closed show a high mean barometric pressure, low mean temperature, more fair weather than usual, and a slightly deficient rainfall.

The mean temperature was 25°.5, the lowest mean we have recorded for December. The average for the last five years, including this year, was 29°.9. The normal for December is 32°.03. The next coldest December occurred in 1882, when a mean temperature of 29°.2 was recorded. The minimum was -5°.6, and the maximum 78°. Our lowest December minimum occurred in 1884, the record showing -32°.4.

#### Summary.

Mean relative humidity, 80.1 per cent.

Mean temperature, 25°.5; highest temperature, 78°.0, on the 11th, at Paulding; lowest temperature, 5°.6, on the 28th, at Paulding; range of

temperature, 83°.6; mean daily range of temperature, 17°.7; greatest daily range of temperature, 57°.0, on the 11th, at Paulding; least daily range of temperature, 2°.0, on the 25th, at Napoleon.

Average number of clear days, 8.8; average number of fair days, 8.4; average number of cloudy days, 13.9; average number of days on which rain fell, 12.4.

Greatest number of days on which rain fell, 18, at Cleveland; least number of days on which rain fell, 5, at New Bremen; mean rainfall, 2.72 inches; average daily rainfall, .088 inch; greatest rainfall, 4.00 inches, at Cleveland; least rainfall, 0.98 inch, at New Bremen.

Prevailing direction of wind, southwest.

The following extracts are from the December, 1886, report of the "New England Meteorological Society," Prof. Wm. H. Niles, of the Institute of Technology, Boston, Massachusetts, president:

#### Summary.

Reports for the month were received from one hundred and fifty-two observers.

The month was decidedly colder than the normal, probably in part owing to the prevalence of snow on the ground almost continuously after the storm of the 2d. The most remarkable feature of the temperature was the occurrence of the maximum of the month about midnight December 24-25th.

The last storm of November, whose central passage over New England caused thunder-storms about midnight of November 30-December 1, moved away slowly, leaving clouds and moderate temperature (maximum 36°-50°) behind it on December 1, and yielding a general snowfall on morning of December 2, which lasted into the night in Maine, clearing off with strong northwest winds. Fair, colder weather followed, as an anti-cyclonic area approached from the northwest, illustrating the gradual development of a cold wave, and on the morning of the 5th, with high pressure (30.7 inches) over northern New England, minimum temperatures of 10° or 5° were generally reached, while the cold in the northern valleys reached -24° at Newport, Vermont, -25° at Berlin Mills, New Hampshire, and -26° at West Milan, New Hampshire.

A cyclonic storm in the Gulf of Mexico foretold its coming by cirrus clouds in the afternoon and lunar halos noted at seventeen stations in southern New England in the evening of the 4th; while still lying off the south Atlantic coast it gave snow, with northeast wind, through the daytime of the 5th in central and southern New England, and from afternoon to night in southern Maine on the 6th, while the storm moved past Cape Hatteras, the winds were more northerly, the snow ceased, and the sky was fair or clear at interior stations; but on the 7th, as the storm-centre crossed the Gulf of Maine, northeast winds, with snow, came again, and extended to northern Vermont, lasting through the daytime in the south, and from noon into night in the north. This was followed by fair weather from the 8th to the 11th, with high pressure to the south, westerly and southerly winds, and rising temperature; on the evening of the 10th five observers report lunar halos, probably to be associated with an area of low pressure whose centre moved over northern Canada on that day.

On the 12th New England was under the influence of a cyclonic storm, moving from Missouri to the Lakes and down the Saint Lawrence Valley; the day was cloudy, and rain began in the afternoon, with northeast winds, at a number of our southern stations; the 13th was generally rainy in the south and snowy in the north, followed by a fine day on the 14th, with winds shifting from easterly to westerly. The 15th opened with a trough of low pressure reaching from Quebec, Canada, to Atlanta, Georgia, giving at first southerly winds, with rain and snow, followed in the afternoon and on the 16th by northerly winds and snow, and a rapid fall of temperature; the change was felt in northern New Hampshire at 14h. on the 15th, temperature 28°, falling 25° in twenty-four hours; and in eastern Massachusetts at 22h., temperature 40°, falling 27° in twenty-four hours; on the 16th the ordinary noonday increase of temperature was generally reversed to a decrease, and minima of -12° in the north and 15° in the south were reached on the night of the 16-17th, with fair weather on the day following.

The following is an extract from the "Tennessee State Board of Health Bulletin" for December, 1886, prepared under the direction of J. D. Plunkett, M. D., President of the State Board of Health. The weather report is prepared by H. C. Bate, Director of the State Meteorological Service:

The main features of the weather during December were the extraordinary fall of snow in the early part of the month, and the entire absence during the month of any electrical disturbances.

The mean temperature was 34°.6, several degrees below the December means of the past three years. The highest temperature was 73°, recorded on the 11th, and was one degree higher than the maximum for December of the two years previous, and five degrees lower than that of 1883. The lowest temperature was -8°, recorded on the 7th, and was seven degrees lower than the minimum recorded in December, 1884, which was thirteen degrees lower than the lowest of December, 1883 and 1885. It was probably the lowest December minimum for many years past. The daily ranges of temperature were generally wide, going as high as forty-six degrees on the 7th and 8th.

The mean precipitation for the month was 3.36 inches. Much of this, especially on the 3d, 4th, 5th, 6th, and 15th, was of snow. Of the amount, the east-

ern division received an average of about four inches, the middle division nearly three and a half inches, and the western division two and a half inches. The greatest precipitation for the month was 5.93 inches, reported at Hohenwald, and the least was 1.48 inches, reported at Nashville. The greatest local daily rainfall was 3.04 inches reported at Hohenwald on the 13th. The next greatest amounts were reported at Jonesborough and Greenville on the 4-5th, and these were of melted snow. The day of the greatest rainfall was the 17th, the corresponding date of the greatest daily rainfall of the month previous. Most of the rains during the month were comparatively light and many of them were general. The 7th, 8th, 9th, 10th, 19th, 20th, were reported without precipitation.

The feature of the month, as above stated, was the great fall of snow which occurred on the 3d, 4th, and 5th. This was the greatest snowfall that, perhaps, occurred in December for many years, and was very heavy in the eastern division, reaching a depth of 36 inches in the extreme eastern portion. In many places the roofs of houses and barns were crushed by the weight of the snow, and travel was almost suspended. In the southern portion of the middle division the depth was much greater than in the northern portion. It was also great in some portions of the western division. Considerable snow also fell on the 15th throughout the state, and this was in many places attended with high winds which caused it to drift greatly. Some snow also fell on the latter days of the month.

#### Summary.

Mean temperature, 34°.6; highest temperature, 73°, on the 11th, at Beach Grove; lowest temperature, -8°, on the 7th, at Farmingdale; range of temperature, 81°; mean monthly range of temperature, 55°.8; greatest monthly range of temperature, 69°, at Beach Grove; least monthly range of temperature, 44°, at Dyersburg; mean daily range of temperature, 14°.7; greatest daily range of temperature, 46°, on the 7th, at Fostoria; least daily range of temperature, 2°, on the 27th, at Hurricane Switch, Waverly, Dickson, and Trenton, and on the 28th at Florence Station and Nashville; mean of maximum temperatures, 60°.7; mean of minimum temperatures, 4°.8.

Average number of clear days, 9.7; average number of fair days, 8; average number of cloudy days, 13.3; average number of days on which rain or snow fell, 9.8.

Mean depth of rainfall, 3.36 inches; mean daily rainfall, 0.108 inch; greatest rainfall, 5.93 inches, at Hohenwald; least rainfall, 1.48 inches, at Nashville; greatest local daily rainfall, 3.04 inches, on the 13th, at Hohenwald; days of greatest rainfall, 4th, 15th, 17th, 24th, 28th, 29th, 31st; day of greatest rainfall, 17th; days without rainfall, 2d, 7th, 8th, 9th, 10th, 19th, 20th; mean depth of snowfall, 13.1 inches.

Warmest days, 11th, 23d; coldest days, 7th, 16th.

Prevailing winds, north and northwest.

#### NOTES AND EXTRACTS.

The question of the temperature relations in the upper air strata during thunder-storms is of so great importance that the following translation of a discussion upon that question has been made by the thunder-storm division. A few notes are appended:

DIPPING OF THE FREEZING-POINT PLANE BEFORE THUNDER-STORMS, BY KARL PROHASKA IN GRAZ.

[Translated from "Das Wetter" of September, 1886.]

Among the lately published theories in relation to the origin of thunder-storm electricity that of Professor Sohneke demands special attention, as well by reason of the completeness of the treatment, as on account of his simple and consistent principle of explaining the cause of the appearances in question. Sohneke sees in the friction of water drops on the particles of ice floating in the atmosphere the cause of electric meteors. From the fact that during thunder-storms cirrus clouds are always to be seen, he makes the deduction that water and snow clouds are there present simultaneously—the first always below, the second generally above, the "freezing-point plane." By ascending currents or greater atmospheric whirls the water particles, when the cirrus clouds are low, can be carried into the region of the ice particles, and in the friction between the particles of the ice and water clouds we would have to seek, according to Sohneke, the origin of thunder-storm and atmospheric electricity.

An essential part of Sohneke's proof rests upon the assumption that the stratum of cirrus clouds at the time of thunder-storms is very low so that contact of the cumuli with the ice particles becomes possible. Sohneke refers to the observations of aeronauts to show that the "freezing-point plane" is especially low before the outbreak of a thunder-storm. The observations of aeronauts bearing on this question by no means reach a positive proof. Sohneke investigated, therefore, the temperature difference due to the difference in height (719 m.) of the stations Freiburg and Hüchenschwand in Baden. His investigations confirmed his supposition that on thunder-storm days the temperature almost always decreases faster from below upward than at other times; for of seventeen cases considered, in which these stations furnished simultaneous thunder-storms, there were only three in which the difference of temperature was below the normal, while in all other cases it was above normal. Also Kaemtz established in his meteorology that a rapid alteration of temperature with height is an important condition in the formation of summer thunder-storms.

Dr. Asmann in his work on thunder-storms in Germany endorses Sohneke's hypothesis. He compared the temperature observations at the stations Sal-

zungen (253 m.), Eisenach (240 m.), and Erfurt (196 m.), with those at Inselberg (906 m.), and found that out of sixty-four days on which thunder-storms occurred simultaneously at the four stations, forty-six, or 72 per cent., had a difference above the normal, fixed by Dr. Hann at 0°.6 to 0°.7 C. for 100 meters in summer.

On the other hand, a comparison instituted by Asmann of the observations at the stations Schneekoppe and Eichberg, furnish negative results in a decision of this question. Professor Hann also expressed himself at the second meeting of the German Meteorological Society in 1885, to the effect that he considered the dipping of the "freezing-point plane" before the outbreak of a thunder-storm as improbable. In the annual report of the Royal Institution of Meteorology and Terrestrial Magnetism at Vienna have been published since 1881 the observations, in detail, at a large number of Austrian stations, among them the high stations Obirgipfel and Schafberg. In order to furnish a contribution, aiding in the decision of this question, I compared the temperature observations at the stations Schafberg (1,776 m.) with those at Salzburg (436 m.) and Kremsmünster (384 m.), and the observations at Obirgipfel (2,044 m.) with those at Klagenfurt (438 m.) and Laibach (287 m.). The data from Salzburg, Kremsmünster, and Laibach, I took likewise from the annual report. The detailed observations for Klagenfurt have been published regularly since 1867 in the annual report of the Natural History Land Museum of Kärnten. I used the material of the four years 1881-1884, and restricted myself to the four months May-August, because in the remaining months there were few simultaneous storms recorded at the low stations and their corresponding high stations.

In the first group above, only those cases, in general, were considered in which thunder-storms were recorded at the three stations, Schafberg, Salzburg, and Kremsmünster, at almost the same time of day, but in some months thunder-storm notes were wanting. I could then depend only on the data from Salzburg and Kremsmünster, and took each day into consideration on which these two stations furnished heavy thunder-storms, and Schafberg great precipitation.

In the second group above there were during the years 1881-1884 relatively few days on which simultaneous thunder-storms occurred at all three stations. I had, therefore, to consider the cases for both valley stations separately. The difference of temperature on thunder-storm days was now taken out for that one of the three daily observations (7 a. m., 2 p. m., 9 p. m.) which was nearest to the outbreak of the storm. In cases where it was difficult to decide this, I gave the preference to the observation hour preceding the storm, because I had to assume that the differences in temperature were largely influenced by the intensity and character of the rainfall, and by other attendant appearances (as a rapid increase in temperature), and did not belong so much to the condition during the formation of the storm.

In order now to decide whether in a special case the differences in temperature were above or below the normal, the mean monthly differences, reckoned from that observation which was nearest the beginning of the storm, were taken out as the normal. In determining whether the difference of temperature in the case of a storm in May, 4-6 p. m., was abnormal or not, the four year mean difference for May, 2 p. m., was taken as the normal, and the departure from that was reckoned. The differences of the mean temperature in the months May-August for the years 1881-1884, are shown in the following table, arranged according to the tri-daily observations:

Mean temperature (Centigrade) differences, 1881-1884.

Month.	(1) Salzburg and Schafberg.			(2) Kremsmünster and Schafberg.			(3) Klagenfurt and Obirgipfel.			(4) Laibach and Obirgipfel.		
	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.
May.....	6.5	10.7	8.3	6.7	10.4	8.4	10.1	13.8	11.4	10.3	14.0	11.3
June.....	7.7	10.7	8.7	7.5	10.3	8.4	10.9	13.4	11.2	10.1	13.7	11.1
July.....	7.1	10.5	8.4	6.9	10.3	8.6	9.4	12.3	10.2	8.9	13.1	10.7
August.....	6.5	10.3	7.6	6.2	9.4	7.7	8.1	11.4	9.7	7.9	11.8	9.7
Mean.....	7.0	10.5	8.2	6.8	10.1	8.3	9.6	12.7	10.6	9.3	13.1	10.7
Mean of all....	8.6	.....	.....	8.4	.....	.....	11.0	.....	.....	11.0	.....	.....

From this table it appears quite plainly that the normal difference in temperature beginning with May, or at least with June, continually decreases till August. This is specially evident in the differences of Laibach-Obirgipfel. In group three, the great difference in June, 7 a. m., is surprising, but may be traced to the fact that at the station Klagenfurt the thermometer during the morning hours was not wholly shielded at the time of the greatest yearly altitude of the sun from radiation influence, which was specially noticeable in the years 1875-1880.

To the yearly period of temperature difference there is a corresponding daily period, in which the maximum is sharply defined at 2 p. m. I thought therefore in the preceding case, that the numbers, which were calculated by Dr. Hann, for the separate months in reckoning the temperature difference with height, would not apply, although the computation would have been simpler, because I held that, on account of the great daily change, it was necessary to consider the time of the thunder-storm as nearly as was possible with the three daily observations. If we take Dr. Hann's value for the fall in temperature with height from May-August, and reckon the amount for the difference of 1,340 and 1,757 metres we shall find in the first case 8°.7, and in the second



case 11°.4, which agree well with the observed values 8°.6 and 11°.0, so that the result for the mean compares well.

The investigation has now shown that in the group Schafberg-Salzburg, for forty-two cases, sixteen had a temperature difference above the normal, and twenty-six below; but in the average of these forty-two cases the difference remained 0°.46 below the normal. In the group Schafberg-Kremsmünster there were forty-two cases; in twenty-six the difference in temperature was above normal, and in twenty-two below it. In the mean it remained 0°.19 too great. In the group Obirgipfel-Klagenfurt, sixty instances were considered. In thirty the difference was above and in thirty below the normal. In the mean of the sixty cases it was 0°.36 less than the normal. Finally, in the group Obirgipfel-Laibach, there were fifty-one cases, the difference in twenty-six of these being greater, in twenty-five less than normal. From the whole one hundred and ninety-five days on which the difference in temperature was compared with the normal, only ninety-two showed a positive and one hundred and three a negative departure, which gave as the mean of all —0°.1.

The result of the investigation is, therefore, not at all favorable to Sohncke's theory, and the majority of cases even makes against it. The comparison of the high stations with the stations Salzburg and Klagenfurt shows that the temperature difference on thunder-storm days is, on the average, 0°.4 (3-5 per cent.) less than the normal. For the stations Kremsmünster and Laibach, on the other hand, the comparison with the corresponding high stations shows a difference of 0°.2 above the normal. The explanation of this contradictory relation of the low stations Salzburg and Klagenfurt, on the one hand, and Kremsmünster and Laibach on the other, is dependent, in my opinion, on the geographical position of the low stations relative to the high. Salzburg and Klagenfurt lie to the west and northwest, Kremsmünster and Laibach to the east and south of their high stations, and because the thunder-storms in the Austrian North Alps come generally from the west, and in the South Alps from the west and northwest, the stations Salzburg and Klagenfurt get the on-coming storms, as a rule, earlier, but Kremsmünster and Laibach later than their high stations. The accompanying reduction in temperature will advance from the west and northwest toward the east and southeast, and therefore, the temperature difference in the case of the stations lying to west and northwest will be too small, and in the case of those to the east and south, too great.

The horizontal distance of low stations from their high stations involves a certain difference in the time of beginning of the storm, and thus this method of investigation furnishes a fruitful source of error, which becomes greater as the distance between the high and low station increases. For this reason we must give the greatest weight to the group, Obirgipfel-Klagenfurt, where the horizontal distance is scarcely 20 km. But the comparison of these stations gives a result opposed to the assumption of a dipping of the "freezing-point plane" before thunder-storms.

Hourly detailed observations or temperature curves from registering apparatus at stations having a significant difference in altitude, and horizontally near each other, would furnish a more accurate method of investigation. But this much appears to have resulted with certainty from this investigation, viz., that if in general a dipping of the "freezing-point plane" does occur before thunder-storms, it makes itself sensible only shortly before the outbreak of the storm (perhaps even as an effect of the storm, not in any way a cause aiding its formation), and only to a slight degree.

## NOTE.

The negative result determined in the above discussion is quite satisfactory as regards temperature changes in the upper strata up to an height of 2,044 metres (6,706 feet). It also seems probable that that height is sufficient to show any marked effects in the case of most storms, as Professor Loomis has proved that a large majority of our storms are developed below the summit of Mount Washington, but it may be held that the conditions may be very different at heights much greater. It would be interesting to compare the observations at the base and summit of the two isolated high stations in this country; Mount Washington in the East (6,279 feet), and Pike's Peak (14,134 feet) in the West. The first has Burlington, Vermont, near sea-level, and the second Colorado Springs, which is about 8,000 feet below the summit. It would seem that the most satisfactory discussion would be of the records at the time of quite heavy rain. All the observations of pressure and temperature during the occurrence of marked rainfall in the summer months of 1873 and 1874 at Mount Washington, and the same for Pike's Peak in 1874, were used in the following tables. Each figure in these tables represents the mean of ten observations. The observations were taken at nearly equal intervals three times each day. The morning observation nearest to the time of the rainfall was taken as the central observation, and seven days records before and after were used. In order to eliminate the diurnal range from the temperature, the difference between the monthly mean for each hour and the mean of all the hours was applied to each observation, *e. g.*, at the morning observation it was always necessary to add a small quantity. This is essentially the method of procedure suggested in the "American Meteorological Journal" for August, 1886.

If the figures in this table be plotted the following facts will be noted:

- (1) The pressure steadily falls for about two days before the centre passes, and rises as steadily for two days after.
- (2) It falls and rises nearly the same amount at the base and summit of Mount Washington, but not quite as much at Pike's Peak as at its base.
- (3) The diurnal range is very marked at Colorado Springs and Pike's Peak and in opposite directions, as was to be expected.
- (4) The temperature fluctuations were not very marked, but were nearly

the same at summit and base; they show a rather uniform increase on the approach of the centre and a sharp fall immediately after it has passed.

(5) The diurnal range has not been quite eliminated but shows, in general, the singular fact that while it is over compensated five to seven days before the centre, it is under compensated two or three days before. This seems to indicate an increased insolation as the centre approaches which causes the p. m. temperature to read relatively much higher near the centre than away from it.

(6) The increase as the rainfall approaches is very slight amounting to about 4° in forty-eight hours; if we regard the velocity of the advancing rain as twenty miles per hour this increase in temperature at the height of Mount Washington would give a gradient of one foot in 100,000, which is inappreciable.

A similar computation for Geneva and Great Saint Bernard indicated the same conditions as above for pressure but much smaller changes in temperature. The latter, instead of rising as the rainfall approached, really reached its maximum, 1°.5, to 2 days before the centre, then fell sharply to about sixteen hours before the centre, when it reached the normal and continued. It will be noted that these facts corroborate the investigation of Professor Prohaska, and indicate that as we ascend in the atmosphere there are no marked fluctuations in temperature on the approach of summer storms. A similar investigation has shown the same for winter storms.

*Pressure and temperature at the base and summit of Mount Washington and Pike's Peak during marked summer rainfall.*

[Mean of ten rains in each column.]

	Summer of 1873.				Summer of 1874.				Summer of 1874.			
	Pressure.		Temperature.		Pressure.		Temperature.		Pressure.		Temperature.	
	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Pike's Peak.	Colorado Springs.	Pike's Peak.	Colorado Springs.
	Inches	Inches	°	°	Inches	Inches	°	°	Inches	Inches	°	°
7 days before.....	33.85	30.93	43.7	67.9	33.66	30.88	38.1	59.0	17.99	24.17	35.5	68.1
	33.87	29.99	42.5	64.4	33.68	30.88	35.6	56.7	18.01	24.12	36.0	68.0
	33.85	30.05	43.3	64.9	33.74	29.93	36.0	58.3	18.04	24.16	36.7	69.1
6 days before.....	33.87	30.09	42.4	65.6	33.72	29.91	37.4	59.1	18.01	24.17	37.8	68.9
	33.88	30.01	41.9	66.6	33.82	29.97	38.2	57.8	18.02	24.11	38.3	68.2
	33.88	30.06	42.8	67.4	33.82	29.96	39.2	59.7	18.03	24.15	37.7	69.5
5 days before.....	33.89	30.11	42.7	66.8	33.80	29.99	39.3	60.1	18.02	24.17	38.8	69.6
	33.92	30.06	42.0	66.4	33.76	29.88	39.9	60.6	18.03	24.12	34.9	67.4
	33.94	30.08	42.8	65.7	33.71	29.88	39.8	60.6	18.04	24.18	36.6	69.0
4 days before.....	33.93	30.06	44.2	69.0	33.69	29.93	38.9	59.9	18.03	24.22	36.8	67.4
	33.90	29.96	45.5	70.0	33.69	29.88	38.2	59.5	18.06	24.17	35.6	67.2
	33.91	30.02	45.5	71.0	33.73	29.91	38.4	60.8	18.07	24.21	36.5	68.0
3 days before.....	33.92	30.09	45.1	69.6	33.74	29.97	39.1	60.4	18.07	24.22	38.1	69.5
	33.91	30.04	44.3	66.8	33.77	29.91	39.5	59.5	18.08	24.17	36.8	71.9
	33.90	30.00	43.1	66.6	33.79	29.97	40.0	58.6	18.08	24.20	38.3	70.0
2 days before.....	33.88	30.12	43.6	67.2	33.85	30.07	39.5	59.0	18.05	24.19	39.1	69.5
	33.88	30.01	42.5	65.9	33.84	29.99	40.1	63.8	18.06	24.12	38.5	72.9
	33.84	30.02	44.5	65.2	33.85	29.97	39.7	63.1	18.05	24.14	39.6	73.0
1 day before.....	33.85	29.98	46.0	66.7	33.80	29.91	41.4	63.5	18.03	24.15	39.9	73.2
	33.78	29.81	48.0	68.4	33.71	29.73	42.7	61.1	18.02	24.08	39.0	73.0
	33.76	29.81	47.6	71.6	33.64	29.71	43.0	64.2	17.99	24.10	38.7	71.7
Centre.....	33.71	29.77	47.2	72.0	33.61	29.71	42.6	63.3	17.97	24.09	38.9	74.2
	33.70	29.79	45.2	62.7	33.59	29.70	38.9	58.9	17.99	24.04	36.4	69.4
	33.71	29.90	43.1	64.0	33.60	29.77	38.2	62.2	17.99	24.11	37.6	69.5
1 day after.....	33.76	29.98	40.5	64.9	33.65	29.91	36.7	57.3	17.99	24.16	36.8	70.1
	33.85	29.99	40.1	65.1	33.72	29.91	37.4	58.4	18.02	24.14	36.8	63.6
	33.90	30.07	40.7	62.4	33.76	29.97	38.5	58.3	18.03	24.19	36.9	66.5
2 days after.....	33.94	30.12	41.9	65.5	33.81	30.09	36.8	60.5	18.05	24.20	37.2	69.5
	33.92	30.03	41.7	64.3	33.88	30.06	38.5	62.1	18.04	24.15	37.7	67.4
	33.90	30.04	43.1	66.4	33.91	30.08	38.3	61.5	18.05	24.19	37.8	67.8
3 days after.....	33.88	30.04	44.0	68.5	33.94	30.14	41.8	61.3	18.04	24.20	37.1	69.8
	33.89	30.00	43.3	65.6	33.95	30.04	43.1	62.0	18.04	24.13	37.3	68.5
	33.89	30.06	43.4	65.7	33.92	30.01	43.5	63.9	18.03	24.17	37.9	69.8
4 days after.....	33.89	30.08	44.2	68.3	33.86	29.97	45.5	64.4	18.00	24.15	37.1	69.4
	33.90	30.00	44.6	67.4	33.80	29.86	43.4	63.3	18.01	24.13	36.9	66.0
	33.91	30.02	45.2	68.9	33.76	29.86	43.5	64.9	18.02	24.17	36.9	67.3
5 days after.....	33.90	30.03	45.5	68.4	33.77	29.90	41.6	64.1	18.01	24.19	36.4	68.2
	33.87	29.94	46.6	68.4	33.71	29.86	39.6	59.1	18.03	24.14	35.8	66.9
	33.84	29.95	46.3	69.9	33.73	29.88	40.2	60.9	18.04	24.20	35.8	66.5
6 days after.....	33.83	29.94	45.0	70.6	33.77	29.96	40.4	62.5	18.03	24.20	35.8	68.9
	33.79	29.87	43.8	66.4	33.78	29.90	41.4	62.3	18.04	24.15	36.9	70.0
	33.77	29.93	44.0	66.2	33.80	29.93	40.7	63.5	18.04	24.20	37.1	69.2
	33.75	29.97	41.2	67.2	33.79	30.01	40.4	63.1	18.03	24.21	37.3	70.7

## METEOROLOGICAL SUMMARY FOR THE YEAR 1886.

[Prepared by Prof. F. H. Snow, of the University of Kansas, from observations taken at Lawrence.]

The year 1886 was marked by an excessively cold January, a long, hot summer, a dry atmosphere, light winds, and clear skies. But the most remarkable characteristic of the year was the very light rainfall of its second half. Up to the 1st of July the rainfall was only 1.79 inches below the average, but for the remainder of the year there was a deficiency of 9.23 inches, the total precipitation being less than half the normal amount. Although the total rainfall was much less than any previous year of our record, the copious rains of the first six months secured good crops of wheat and half crops of corn in the districts most seriously affected by the drought.

*Temperature.*—Mean temperature of the year, 52°.96, which is 0°.04 above

the mean of the eighteen preceding years. The highest temperature was 105° on August 16th; the lowest was 18° below zero on the 9th of January, giving a range of 123°. Mean at 7 a. m., 47°.13; at 2 p. m., 62°.16; at 9 p. m., 51°.28.

Mean temperature of the winter months, 23°.33, which is 5°.88 below the average winter temperature; of the spring, 54°.57, which is 0°.96 above the average; of the summer, 76°.80, which is 0°.96 above the average; of the autumn, 57°.17, which is 3°.39 above the average.

The warmest month of the year was July, with mean temperature 79°.54; the warmest week was August 11th to 17th, mean 86°.93; the warmest day was August 16th, mean 90°.62. The mercury reached or exceeded 90° on fifty-three days, thirteen more than the average number, viz.: two in May, three in June, twenty-one in July, eighteen in August, and nine in September. There were five days on which the temperature exceeded 100°—one in July and four in August.

The coldest month was January, with mean temperature 14°.32; the coldest week was January 6th to 12th, mean temperature 0°.61 below zero; the coldest day was January 8th, mean 12°.75 below zero. The mercury fell below zero on sixteen days, of which ten were in January, three in February, and three in December.

The last hoar frost of spring was on April 27th; the first hoar frost of autumn was on October 1st; giving an interval of one hundred and fifty-five days, or over five months, entirely without frost. This is precisely the average interval.

The last severe frost of spring was on April 5th; the first severe frost of autumn was on the 27th of October; giving an interval of two hundred and three days, or nearly seven months, without severe frost. The average interval is one hundred and ninety-eight days. No frosts during spring and autumn caused damage to crops of grain and fruit, but the low temperatures of January were universally destructive to peach buds.

**Rain.**—The entire rainfall, including melted snow, was 24.25 inches, which is 11.02 inches below the annual average. Either rain or snow, or both, in measurable quantities, fell on one hundred and three days—one less than the average. On fifteen other days rain or snow fell in quantity too small for measurement.

The number of thunder-showers was twenty-eight. There was but one light hail storm during the year.

The drought which prevailed during July, August, and September, was the only serious drought in Kansas since 1874. From June 26th to July 24th, an interval of twenty-seven days, there was entire absence of rain. From the same date to September 16th, a period of eighty-one days, the rainfall was but 2.85 inches. In 1874 the drought extended from June 14th to September 3d, an interval of eighty days, during which the rainfall was only 2.19 inches. Thus the drought of 1886 was one day longer than that of 1874, but the latter began nearly two weeks earlier in the season and was, therefore, more disastrous in its effects.

#### FREQUENCY OF LIGHTNING STROKES.

[From Beiträge zur Statistik der Blitzschläge in Deutschland, von Dr. Hellmann, Berlin, 1886; Zeit. d. Königl. Preuss. Stat. Bureau, 1886. Translated by ALEX. McADIE, Sergeant, Signal Corps, U. S. Army.]

A summary of the results of the investigation on the frequency of lightning strokes in Germany appears as one of the reports of the Royal Prussian Bureau of Statistics. As it deals directly with risk of damage to buildings from lightning the main conclusions of the investigation are here given:

The observations from which the following conclusions are drawn have been made in different parts of the German Empire for the past ten years.

1. Statistics show that in Schleswig-Holstein, Baden, and Hesse, in thickly settled districts, a constant increase of damage from lightning does not appear to be proven any more than a decrease.

2. The yearly as well as the daily periodicity of lightning flashes corresponds

very closely with the storm frequency. One interesting fact, previously noted, is that on the west coast of Schleswig-Holstein the greatest number of lightning flashes occur in the first hours after midnight.

3. In Schleswig-Holstein, in the ten years from 1874 to 1883, of all the buildings struck by lightning, of those with "hard" roofing, 9 per cent. caught fire, 91 per cent. did not; with "soft" roofing, 68 per cent. caught fire, 32 per cent. did not; so that buildings with "soft" roofing when struck by lightning catch fire from seven to eight times as often as those with "hard" roofing. Besides this consideration of the nature of the roof, the nature of the building is of importance. Averaging for a year of a million instances:

Ordinary buildings (with "hard" roofing, 163, with "soft" roofing, 386) 290 are struck; churches, 6,277 are struck; wind-mills, 8,524 are struck; manufactories, chimneys, etc., 306 are struck.

In Schleswig-Holstein, the risk from lightning to churches and bell-towers is thirty-nine times, and in the case of wind-mills fifty-two times, greater than in the case of ordinary buildings with hard roofs.

4. In the case of Schleswig-Holstein the marsh lands from Husum to Steinberg are often struck while the country around the fiords of the east coast is entirely protected. The coefficient representing the number of buildings struck of a million is generally from four hundred to five hundred and forty; but here falls to one hundred and sixty or one hundred and seventy, i. e., about one-third. The great danger in the case of flat and moist lands comes from the fact that the farm premises are the most prominent features of the landscape, and the ground, besides, is quite moist.

5. The risk of danger from lightning decreases with increase of number of houses contained in any given district. In Prussia the risk in the country is five times greater than in the city districts. In Berlin the number of fires caused by lightning averages only 0.2 to 0.3 of one per cent. For an ordinary dwelling house, which stands among others, not particularly high, the erection of a lightning-rod is not needed.

6. In the Grand Duchy of Baden differences in the distribution of lightning strokes are found. In Heidelberg of a million, twenty-four buildings are struck, while in Waldshut the rate is two hundred and sixty-five.

7. In the northern half of Baden and the neighboring half of Hesse the number of buildings struck between 1868 and 1883 shows a decrease.

8. In Hesse the parts protected best are regions along the Rhine, where the encircling hills and mountain sides are interposed to protect them. But the danger is increased where, as in the case of Rhine Hesse, the country above is wooded.

9. The causes of variations in the number of buildings struck are to be sought in local causes and not in extra-territorial happenings. The supposed relation between frequency of lightning strokes and sun spots appears to have no foundation.

10. Averaging for fifteen years, of a million of people, the number killed by lightning is, in Prussia, 4.4; Baden, 3.8; France, 3.1, and Sweden, 3.0.

11. The geological features of the ground, particularly the water capacity, have a marked influence upon the number of lightning strokes. If we call a chalk-bed, 1; then we have for marl, 2; for clay, 7; for sand, 9, and for loam, 22. These conditions have much to do with the frequency of lightning strokes in the flat lands of northern Germany, as compared with southern Germany and Austria.

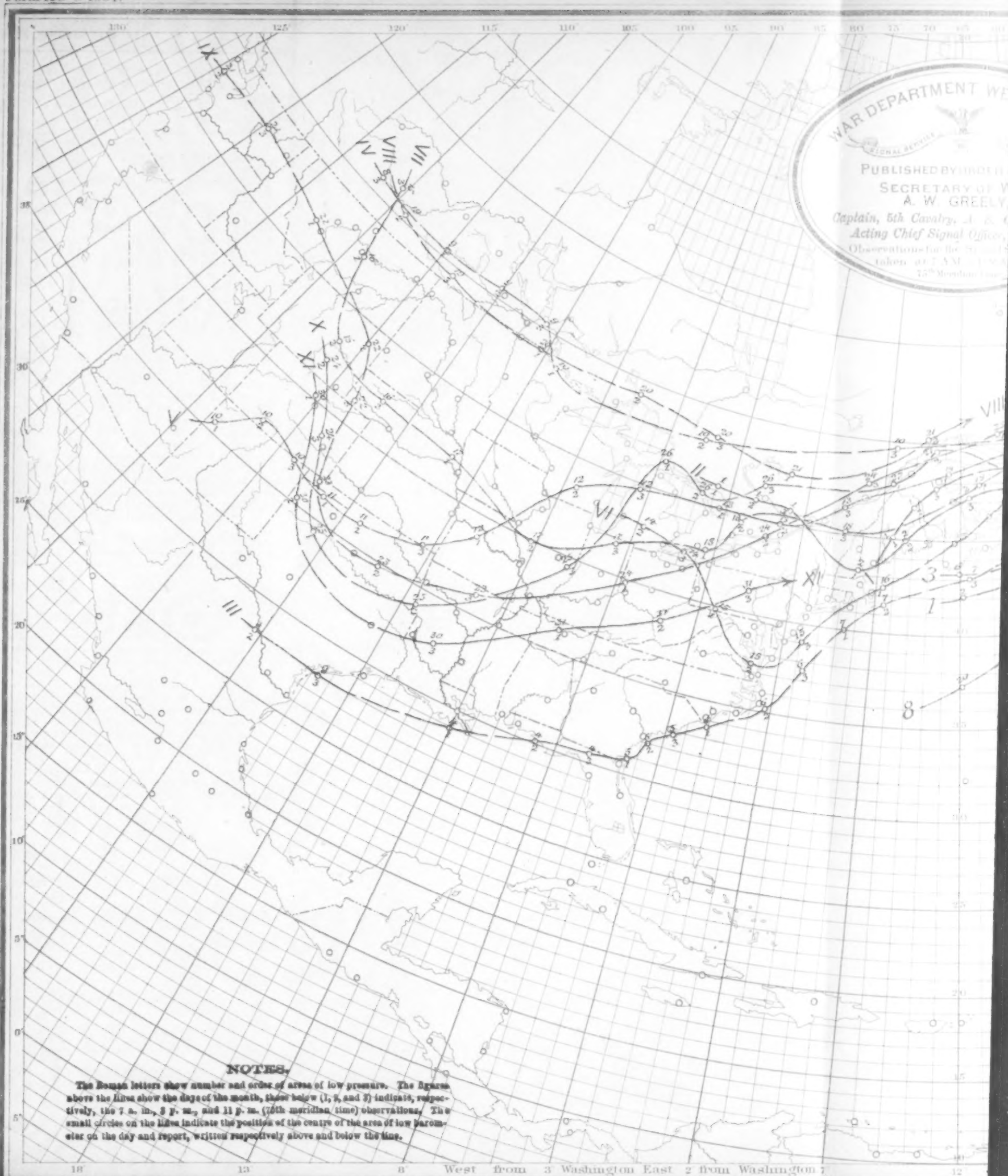
12. Differences in space and distribution of lightning strokes are due to four causes; two of a physical and two of a social nature. The first, the unequal frequency of storms, and the difference in the geological character of the earth; the latter, the changing and the improved construction of buildings.

13. Of all trees, the oak was most frequently and the beech least frequently struck. If we let 1 equal the beech, then pines are 15, oaks 54, and other trees, 40.

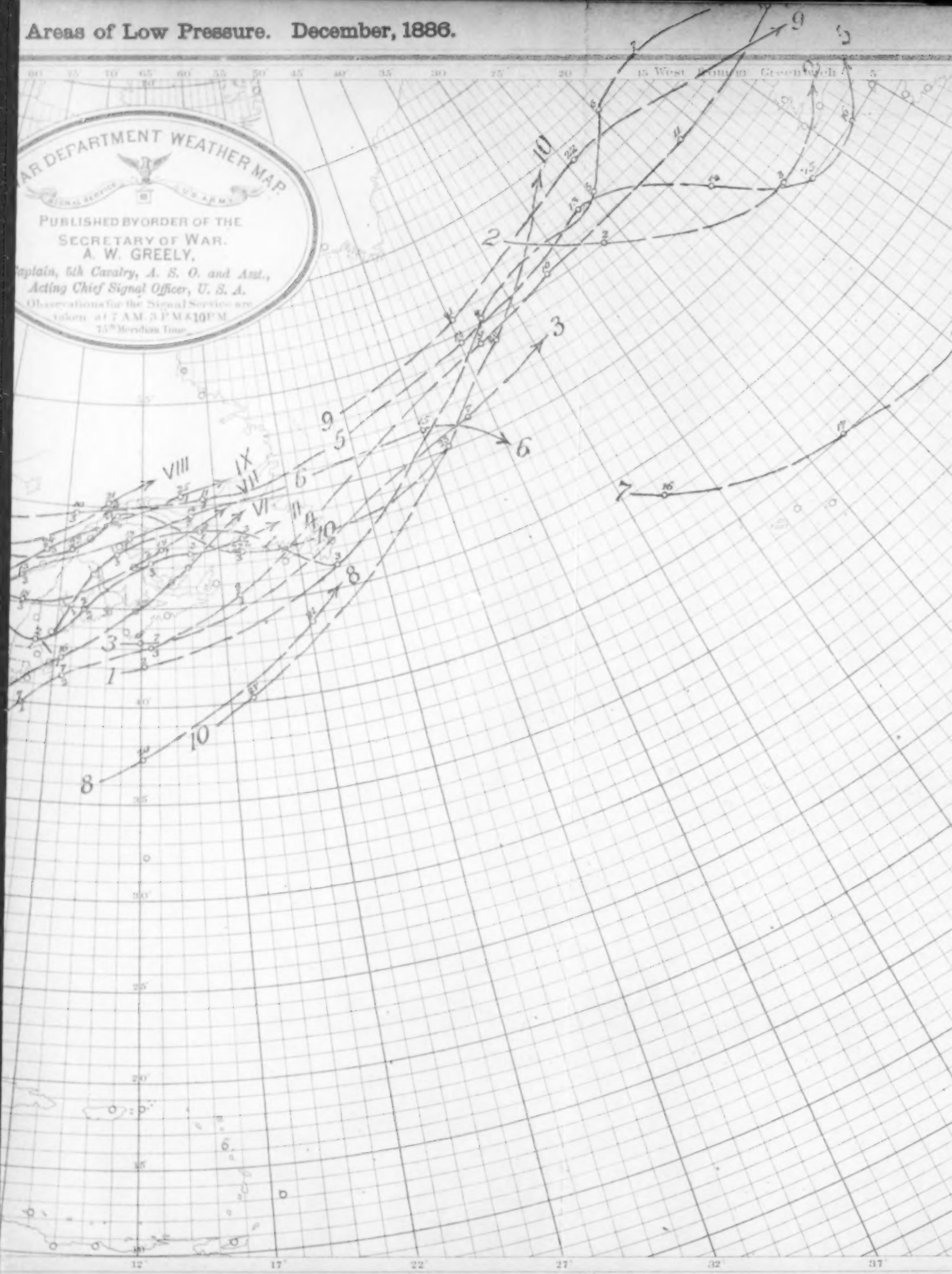
14. Most frequently the trees struck were standing in the clear, or on the edge of forests, and averaging from sixteen to twenty metres high.

15. The trunk is struck about three times as often as boughs, and generally the stroke seems to travel toward the ground. Only in three of one hundred cases did it jump to other trees.





# Areas of Low Pressure. December, 1886.





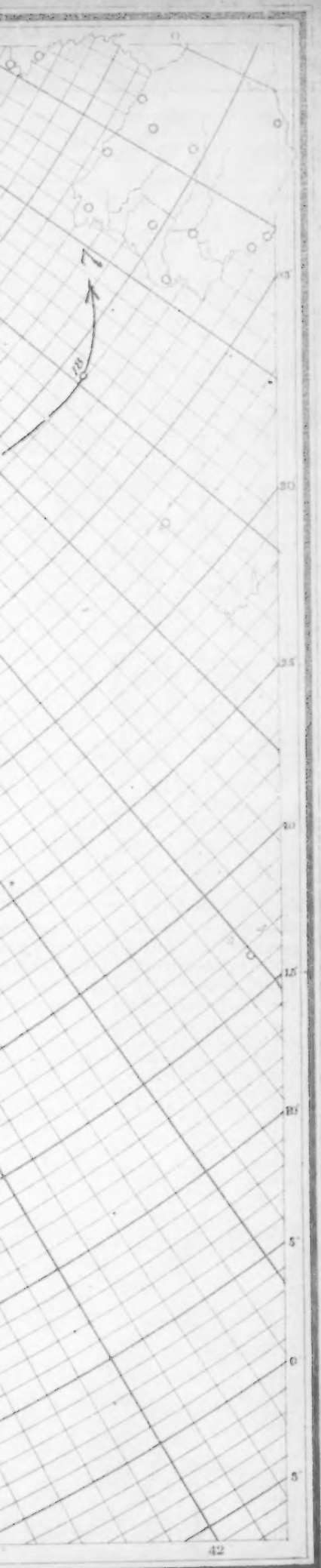












Chart III. Precipitation, December: 1886.

Form 106 F.

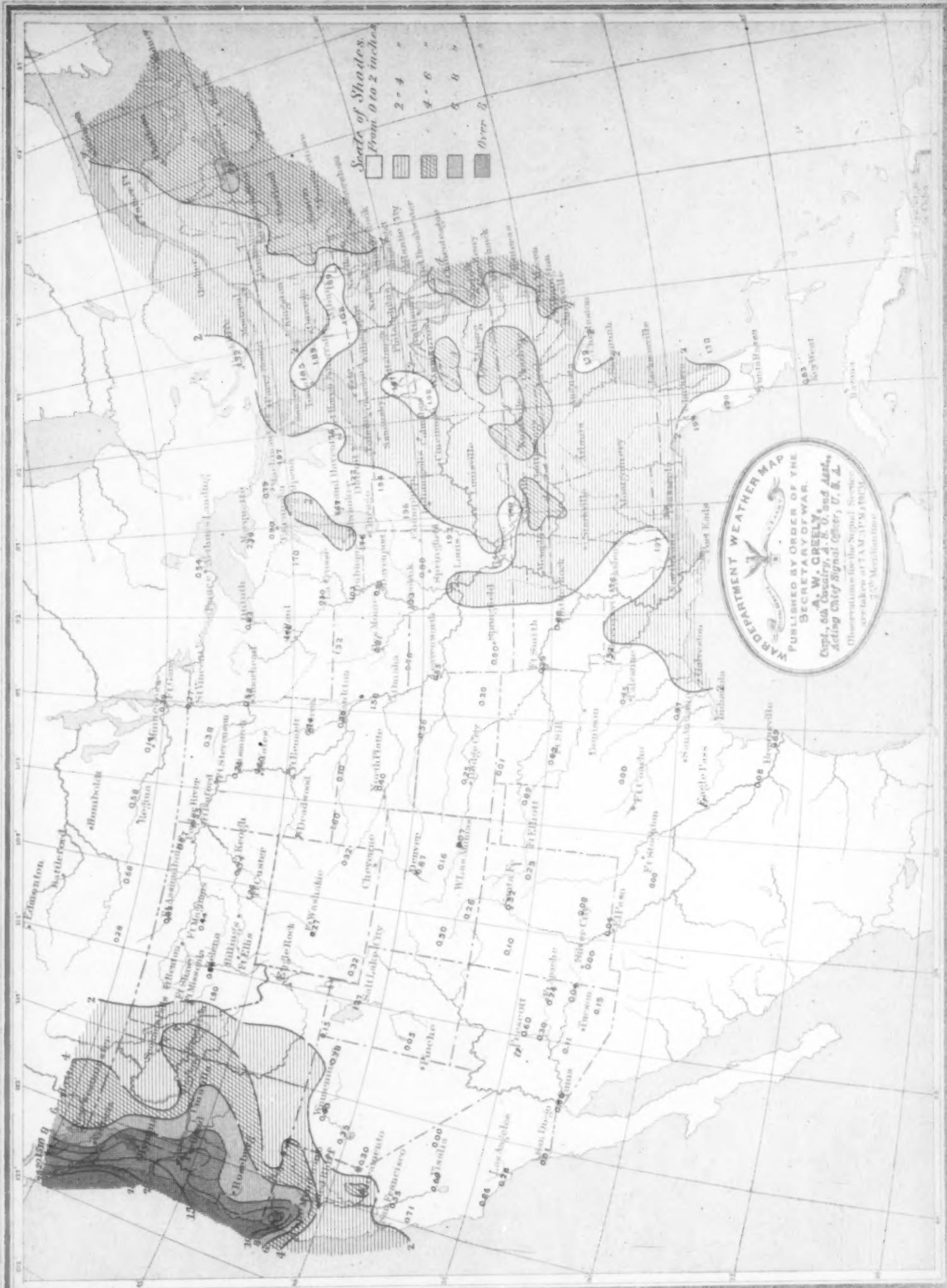






Chart IV. Departures from Normal Atmospheric Pressure and Temperature. December, 1886.

FORM 106 F.

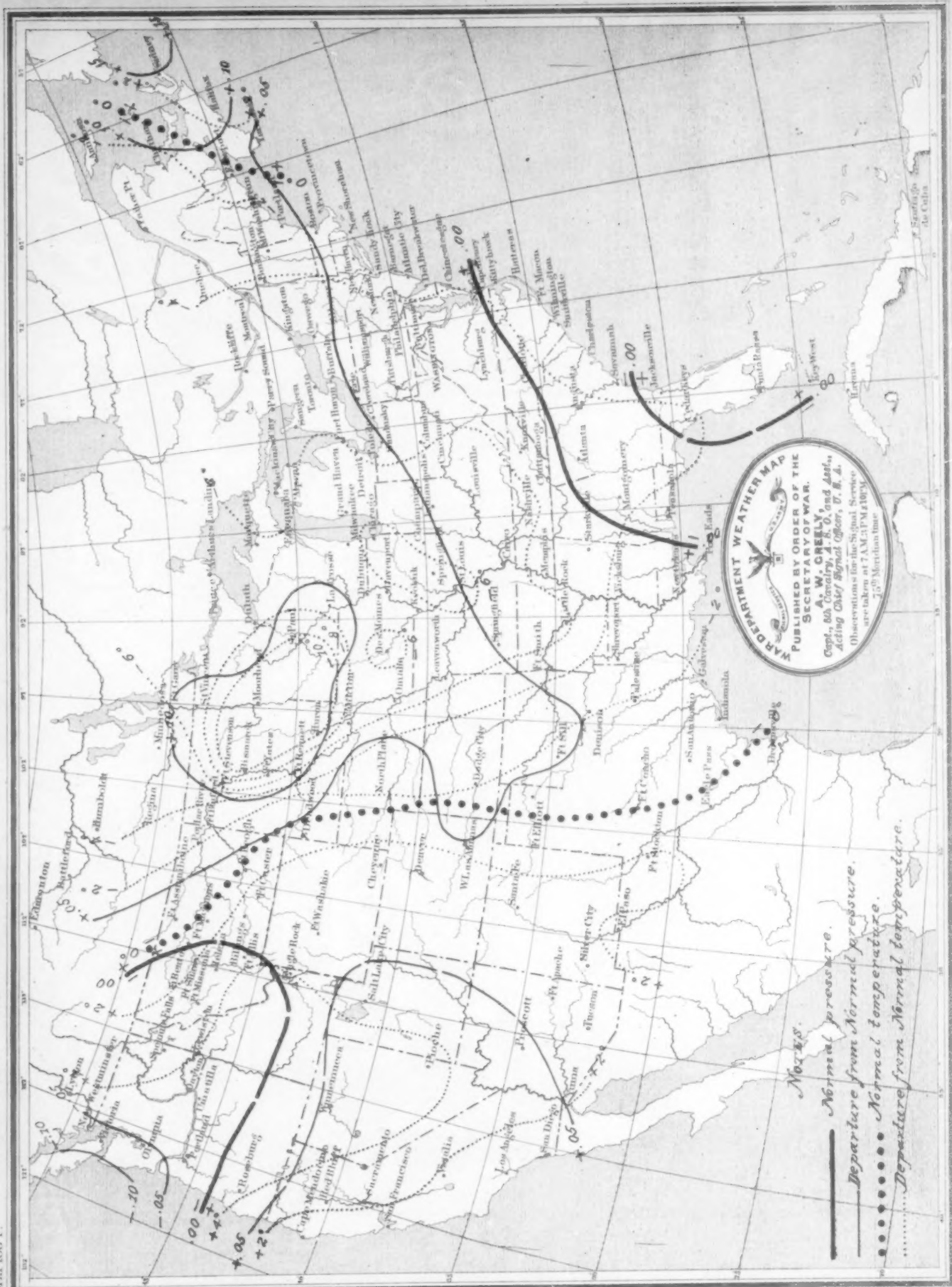
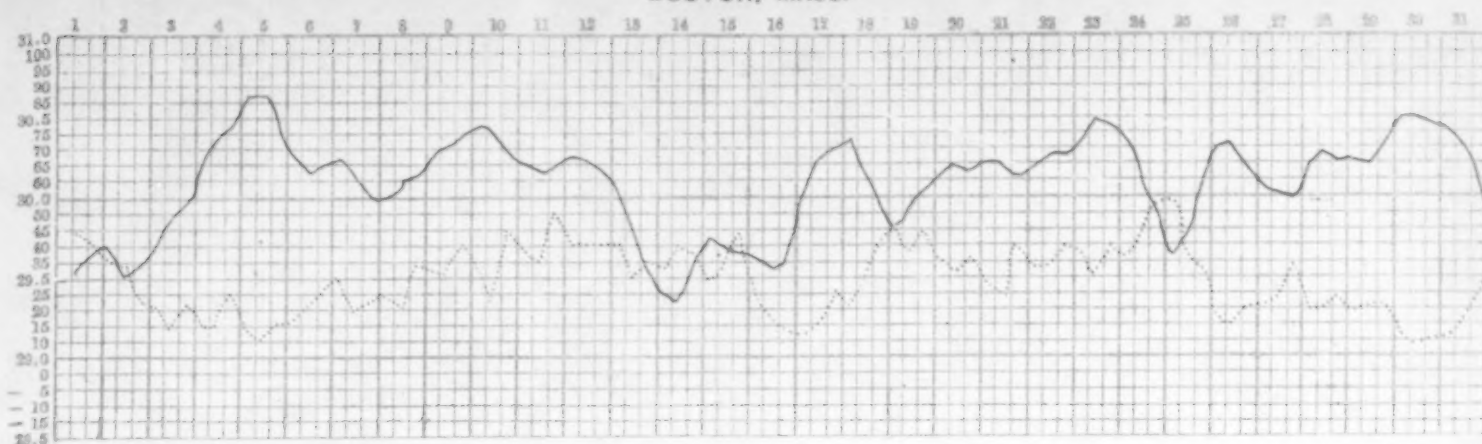


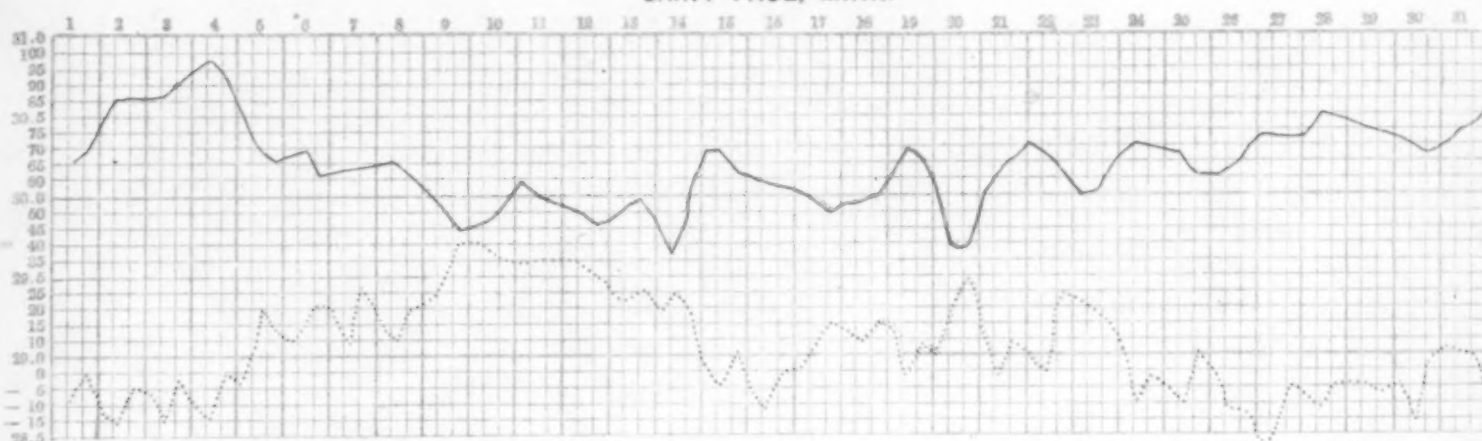




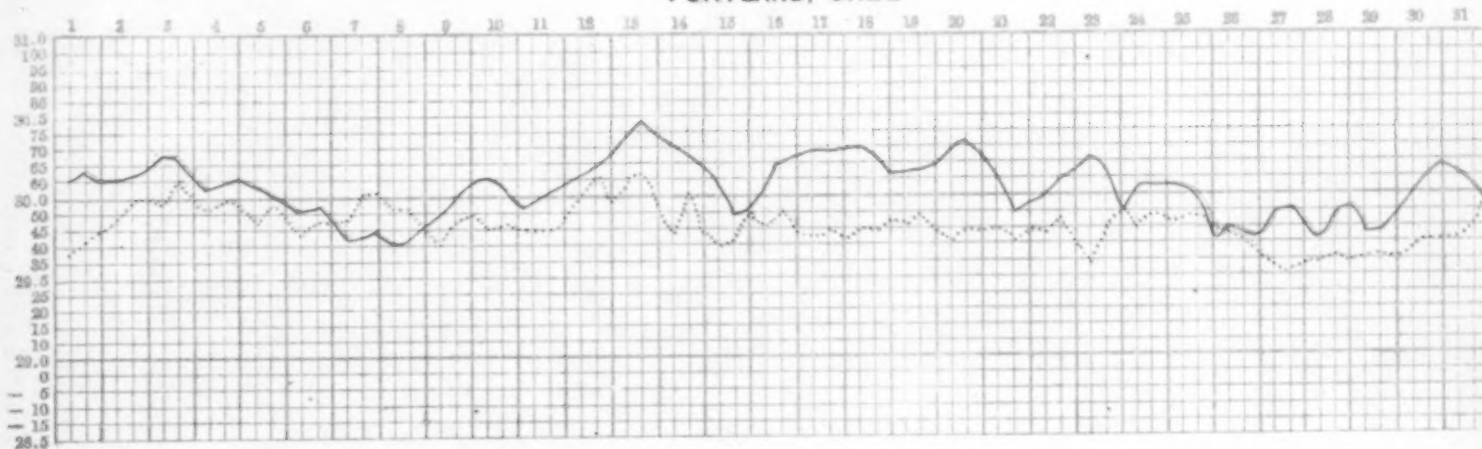
Chart V. Pressure (——) and Temperature (.....) Curves. December, 1886.  
BOSTON, MASS.



SAINT PAUL, MINN.



PORTLAND, OREG.



NEW ORLEANS, LA.

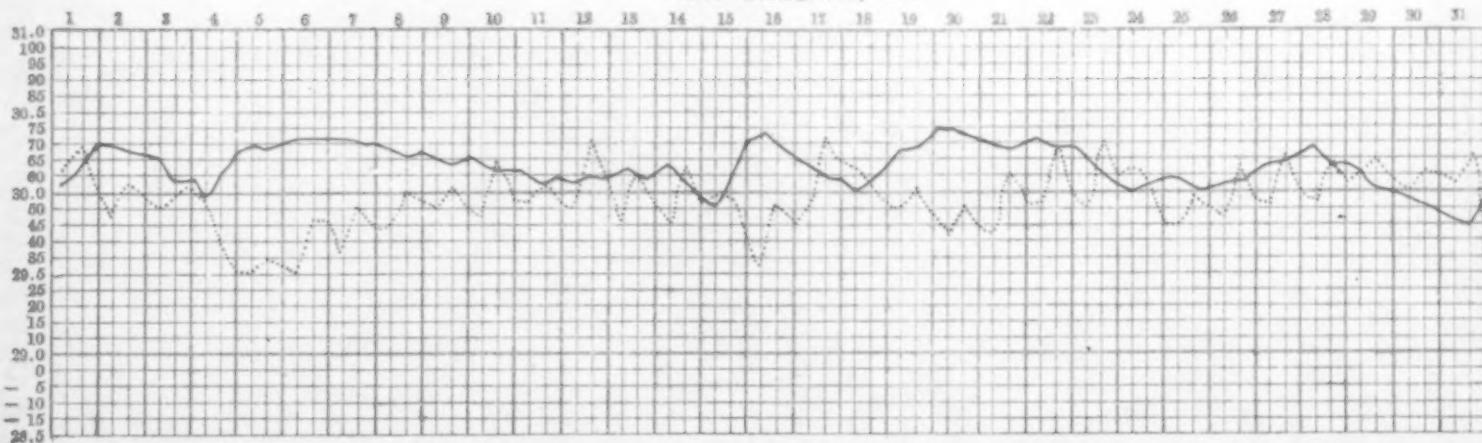
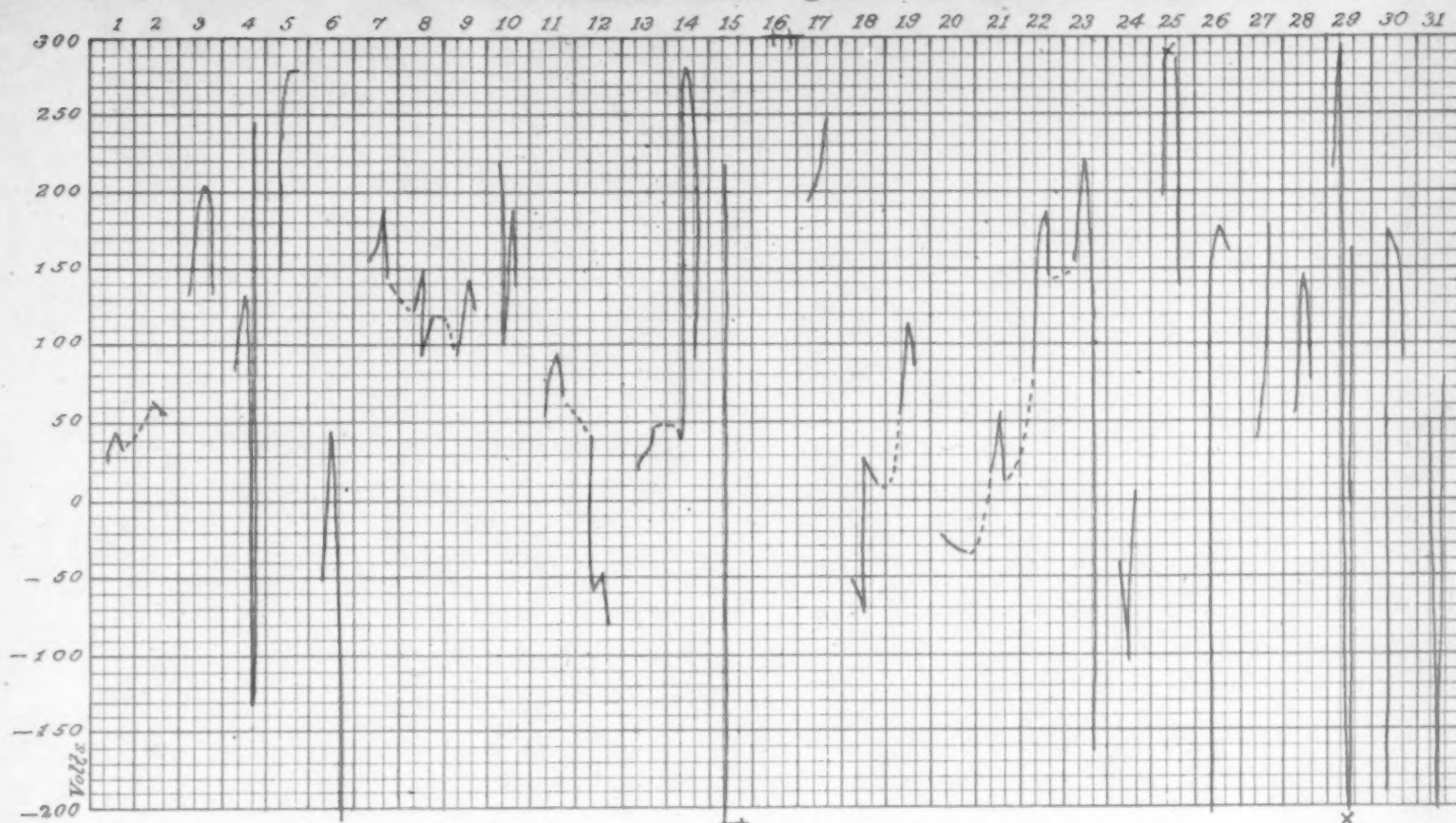


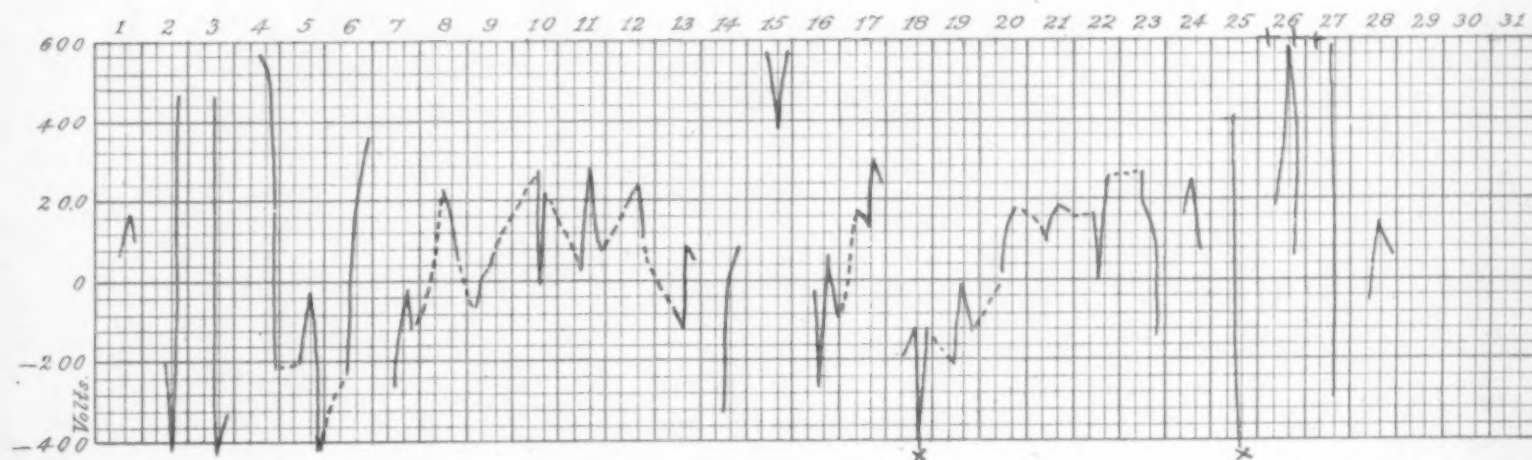




Chart VI. Curves showing Electrometer Readings.



Boston, Mass., December, 1886.



Ithaca, N. Y., December, 1886.



New Haven, Conn., December, 1886.





Observer and place of observation.	Observer and place of observation.	Observer and place of observation.	Observer and place of observation.
Alexander, S., Birmingham, Mich.	Dunlap, W. L., Tecumseh, Nebr.	Knapp, J. G., Limona, Fla.	Shriver, E. T., Cumberland, Md.
Anderson, Dr. W. W., Stateburg, S. C.	Dazy, J. B., Charleston, Ill.	Keece, G. Pomeroy, Cooperstown, N. Y.	Shepard, H. M., Springfield, Mo.
Altner, J. M., Independence, Kans.	Deming, H. D., Wellsborough, Pa.	Kuhn, F. W., Fort Wayne, Ind.	Sanders, T. B., Susanville, Cal.
Adams, Dr. O. H., Vineland, N. J.	Doxier, Wm., Mattoon, Ill.	Lincoln, A. T., Marion, Va.	Shriver, Howard, Wytheville, Va.
Abbott, Dr. E. K., Salinas, Cal.	Dawhurst, Rev. E., Voluntown, Conn.	Ladshaw, G. E., Pacolet, S. C.	Scott, Thos. G., Forsyth, Ga.
Arents, Hiram, Oroville, Cal.	Day, Theodore, Dyberry, Pa.	Lueps, Miss Anna, Manitowoc, Wis.	Smith, Prof. T. B., Fayette, Mo.
Adams, A. H., Fort Meade, Fla.	Ellsworth, W. W., Hartford, Conn.	Loomis, J. C., Jeffersonville, Ind.	Stucky, Dr. C. T., Helvetia, W. Va.
Avey, O. H., Oskaloosa, Iowa.	Eliason, W. A., Statesville, N. C.	Luther, S. M., Garrettsville, Ohio.	Slade, Eliza, Somerset, Mass.
Beans, Thos. J., Moorestown, N. J.	Ellis, John, Marquette, Nebr.	Loud, Prof. F. H., Colorado Springs, Colo.	Sonedecker, Rev. T. H., Tiffin, Ohio.
Bushnell, W. S., Monticello, Ind.	Ewell, Dr. M. D., South Evanston, Ill.	Lerch & Rice, Bethlehem, Pa.	Smith, John R., North Truro, Mass.
Bentley, David, Princeton, Cal.	Eckstein, Rev. M., Conception, Mo.	Louder, E. T., Charksburg, W. Va.	Sim, J. R., Summit, Va.
Boerner, Prof. Chas. G., Vevay, Ind.	Ford, H. C., El Dorado, Kans.	McDonogh Institute, McDonogh, Md.	Scribner, H. F. J., Strafford, Vt.
Blochman, L. E., Santa Maria, Cal.	Fox, F. E., Fall Brook, Cal.	Morgan, L. Ray, Philipaburg, Pa.	Strong, S. B., Setauket, N. Y.
Bayerly, J. F., Spartanburg, S. C.	Ferris, B. F., Sunman, Ind.	Marshall, Gregory, Cresco, Iowa.	Samostz, Oscar, Austin, Tex.
Ballou, Dr. N. E., Sandwich, Ill.	Friend, Chas. W., Carson City, Nev.	Mackey, T. C., Gardiner, Oreg.	Smith, George F., New Midway, Md.
Bennett, Geo., Bandon, Oreg.	Ferguson, Wm., Paterson, N. J.	Massachusetts Agricultural Experimental Station, Amherst, Mass.	Standenmayer, Dr. L. R., Lincoln, N. C.
Bell, Joseph, Franklin, Pa.	Ferrill, B. P., Duke, Fla.	St. Mary's College, Emmitsburg, Md.	Swezey, Prof. G. D., Crete, Nebr.
Beecher, Chas., Wycox, Pa.	Fernald, Prof. M. C., Orono, Me.	McCready, Miss L. A., Fort Madison, Iowa.	Trembley, Dr. J. B., Oakland, Cal.
Baker, Dr. Henry B., Lansing, Mich.	Fleming, John, Readington, N. J.	Montgomery, J. H., Meadville, Pa.	Tillinghast, C. B., Albany, N. Y.
Beall, Dr. R. L., Lenoir, N. C.	Fuller, Edw. N., Tacoma, Wash. T.	McClintock, Frank, West Union, Iowa.	Tilford, C. M., Mount Blanco, Tex.
Brendel, Dr. Fred., Peoria, Ill.	Featherston, Wm., Globe, Kans.	McKenzie, Dr. M., Centerville, Mo.	Thornton, Prof. N., Geneseo, Ill.
Bartlett, E. B., Vermillion, N. Y.	Field, T. G., Parkersburg, W. Va.	Moore, C. R., Bird's Nest, Va.	Teale, Rev. A. K., Blue Hill, Mass.
Briggs, John, Albany, Oreg.	Gibson, J. H., Salina, Kans.	Mikecell, Thos., Wauseon, Ohio.	Truman, Geo. S., Genoa, Nebr.
Betta, Prof. Arthur, Webster, Dak.	Gore, Prof. J. W., Chapel Hill, N. C.	Micklen, J. H., Variety Mills, Va.	Turnbo, Silas C., Pro Tem, Mo.
Breed, J. E., Embarras, Wis.	Gray, F. R., Yates Centre, Kans.	Macrae, Colin, Kirkwood, S. C.	Terborg, Rev. J. E., Pekin, Ill.
Baldwin, A. L., Bethel, Conn.	Gates, W. B., Burlington, Vt.	Miller, H. D., Drifton, Pa.	Thompson, R. J., Tiffin, Ohio.
Boies, Lieut. A. H., Hudson, Mich.	Graves, A. B., Belleville, Kans.	Meuninger, E. R., Flat Rock, N. C.	Van Gieson, F. L., Upper Montclair, N. J.
Broberg, Mrs. Mary W., Manatee, Fla.	Gillingham, Milnor, Fallington, Pa.	Moore, Dr. J. W., Easton, Pa.	Vall, H. D., Santa Barbara, Cal.
Black, W. H., Kalamazoo, Mich.	Gordon, Dr. G. G., Swartz Creek, Mich.	Moore, Nathan, Grampian Hills, Pa.	Voegeli, Adolphus, Des Moines, Iowa.
Blackly, C. P., Manhattan, Kans.	Gowey, H. D., North Lewisburg, Ohio.	Motte, L. S., West Milton, Ohio.	Went, E. C., Frankfort, Ky.
Bridges, C. A., Berlin Mills, N. H.	Green, Dr. Jesse C., West Chester, Pa.	Newcomb, G. S., Westborough, Mass.	Washburn Observatory, Madison, Wis.
Bowman, Peter, Ruggles, Ohio.	Gerrish, S. H., Sacramento, Cal.	Newell, W. C. T., Henry, Dak.	Wild, Rev. E. P., Newport, Vt.
Calhoun, P. B., Austin, Tenn.	Geddings, Dr. W. H., Aiken, S. C.	Norcom, Prof. T. J., Reidsville, N. C.	Williams, Rev. C. F., Ashwood, Tenn.
Cook, S. A., Milledgeville, Ga.	Gray, J. W., Stockham, Nebr.	Neal, Dr. J. C., Archer Fla.	Wing, Miss M. E., Charlotte, Vt.
Carrington, H. D., Brownville, Nebr.	Goodwin, Wm., North Colebrook, Conn.	Nordberg, Prof. A., Richardson, Dak.	West, Silas, Cornish, Me.
Clark, A. C., Wausau, Wis.	Goodspeed, Chas. W., Elyria, Ohio.	Osborn, Dr. T. C., Cleburne, Tex.	Wyllie, Wm., Mount Forest, Canada.
Charbonnier, Prof. L. H., Athens, Ga.	Gillingham, W., Acetoint, Va.	Olds, H. D., Cedar Rapids, Iowa.	Wait, S. E., Traverse City, Mich.
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State weather services from which meteorological reports were received in time to be used in the preparation of the Monthly Weather Review for December, 1886.

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Minnesota State Weather Service, under direction of Prof. W. W. Payne, Northfield, Minnesota.  
Missouri State Weather Service, under direction of Prof. Francis E. Nipher, Saint Louis, Missouri.  
New England Meteorological Society, Prof. Wm. H. Niles, of Boston, Mass., President; Mr. W. M. Davis, of Cambridge, Mass., Secretary.  
Ohio State Weather Service, under direction of Prof. B. F. Thomas, of the Ohio State University, Columbus, Ohio.  
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